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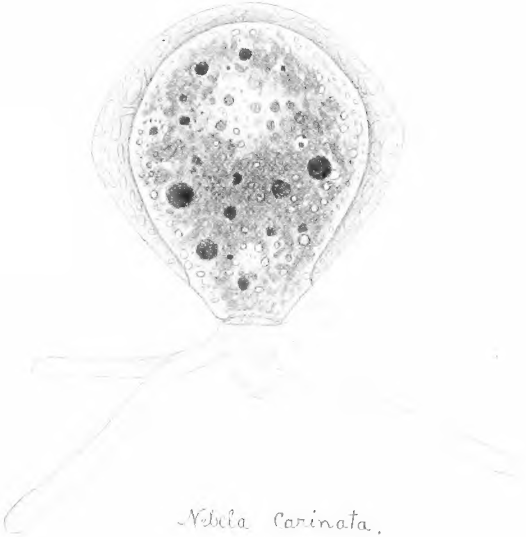
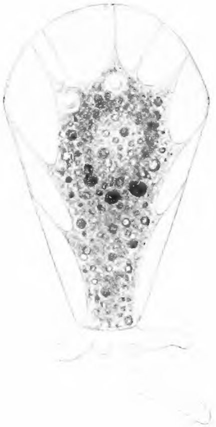


Nebela Carinata.



Hyalosphenia papilio.

THE

BRITISH FRESHWATER RHIZOPODA AND HELIOZOA

BY THE LATE

JAMES CASH

ASSISTED BY

JOHN HOPKINSON, F.L.S., F.Z.S., F.R.M.S.,
ETC.
Secretary of the Ray Society

VOLUME II

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THE HISTORY OF THIS WORK.

In November, 1902, amongst the letters written to our late Secretary, the Rev. Dr. Wiltshire, I found one dated 8th July, 1902, commencing thus :

> "A life-long friend, Mr. James Cash of Manchester, has devoted thirty years' time, special knowledge, and enthusiasm, to the writing of a Monograph on the Rhizopoda. He has also done with his own hands an excellent and adequate equipment of plates to illustrate the text, and, I speak as an old Quekett man, these drawings are distinguished by an ideal measure of faithfulness to nature, loving care, and artistic beauty."

This letter was from a bookseller, Mr. A. F. Tait, of Queen Street, Cheapside, and then proceeded to name two of our chief publishers, both especially well known as publishers of natural history books, who, while expressing approval of the work, would not undertake it unless the author would bear the whole risk of publication, which he was not prepared to do. The letter concluded :

> "As there is no British Monograph of the Rhizopoda, possibly the Ray Society might be disposed to entertain the question of publication, if so I would be glad to forward Mr. Cash's MS. for inspection."

In reply Dr. Wiltshire appears to have written for fuller information about the work. Mr. Tait was then with Mr. Cash at Criccieth and promised to give this on his return to London, but no further letter could be found. I therefore called upon him, and he entrusted the MS. and drawings to me.

I found the work to be on the British Freshwater Rhizopoda and Heliozoa, intended to be brought out as a small 8vo volume of about 150 pages with 38 admirably executed but uncoloured plates, which in our larger size of demy 8vo could well be reduced to 30 or less. It was therefore suitable for a single volume. A letter written to Mr. Tait, the main purport of which was to ask him if the figures or any of them could be coloured, brought a reply direct from Mr. Cash, which is here given.

> "My friend Mr. Tait writes to me with reference to my 'Introduction to the Study of the British Freshwater Rhizopoda,' offered to the Ray Society for publication, and your enquiry as to the colouring of the figures. I am decidedly of opinion that the figures should be coloured, and am so interested in this being faithfully done that I would undertake to submit nearly the whole of the species to fresh microscopical examination for the purpose, during the coming year. Very few would need to be left in black and white."

This letter is dated 29th November, 1902, and is the commencement of an extensive and very pleasant correspondence with Mr. Cash during the last seven years. In reply I suggested that he should colour a figure as a specimen, to submit to our Council at a meeting on 11th December. The day before the meeting I received the two figures reproduced as a frontispiece. Mr. Cash stated that they had been "rather hurriedly executed from pencil memoranda," but they are of exceptional interest as giving the result of his first attempt at coloured drawings of rhizopods, and they are excellent representations of

Hyalosphenia elegans and *Nebela carinata*, both being species which are described in this volume. Their names on the plate are as written in pencil by him.

The work was accepted by the Council, subject to a satisfactory estimate being obtained for the reproduction of the plates, and this being submitted it was definitely accepted at a Council meeting held on 26th March, 1903, the idea then being to bring it out as a single volume for the year 1905. It was subsequently decided (12th May, 1904) to divide it into three volumes, each of less extent than the one would have been, while the whole would be of considerably greater extent than was at first anticipated. It was also decided that each volume should appear for the same year as a larger botanical volume, following the plan adopted with the first volume of the 'British Tunicata.' For this arrangement there were two reasons: (1) It was found that so much had to be done that only a portion of the work could be brought out within a reasonable time, and that it could more conveniently be divided into three than into two volumes; and (2) that as nearly all our personal subscribers are zoologists, it would not be advisable to give to them for their year's subscription a botanical work only, the division of the monograph into three volumes meeting our requirements in this respect for some years.

Mr. Cash was then living at Northenden, Cheshire, and had not the opportunity of consulting many books on the subject of his monograph. He was consequently acquainted with only a small portion of the literature relating to the Freshwater Rhizopoda which had been produced in recent years, in Germany especially, and I found that several of his drawings which were either un-named or considered by him to be new species, represented species which had been described by German authors in papers to which he had not access. An offer to assist him in regard to the literature was accepted in a letter dated 21st February, 1903, in which he thus made the generous proposal that the work should be brought out under our joint authorship:

> "I confess to a sad want of acquaintance with the works of Continental authors on this subject. It is inevitable, as there is no access here, for any student, to the most recent German works on the Rhizopoda. The only one I have been able to see of recent date is Schönichen and Kalberlah's 'Süsswasserbewohner,'* in which I find a system of classification substantially the same as Blochmann's,† a copy of which you were good enough to send to me. In the circumstances, and as it is so necessary to have the work on the British Rhizopoda complete, would it not be well for your name to be associated with mine in a joint authorship? If you can agree to this it would please me, and be much more satisfactory in the end."

Although this proposal was at first declined, the amount of work which devolved upon me proved to be so great that it was subsequently arranged that my name should be associated with that of Mr. Cash as it appears on the title-page.

The first volume was issued, together with the second volume of the 'British Desmidiaceæ,' for the year 1905, in December of that year.

Coming now to the present volume, arranged to be issued for the year 1908 with the third volume of the 'British Desmidiaceæ,' I received from Mr. Cash a list of the species to be described in it, with a few references, on 29th October, 1907. Commencing at once to work up the synonymy of those species so far as could be done before the figures and descriptions of them were to hand, I thought that the volume would be ready by the end of the year for which it was to be issued, but the descriptions of the species were only completed at the end of that year and were received by me on 1st January, 1909. Several species described were not in the previous list, and working up the bibliography for these and completing it so far as possible for the rest has taken all the time that I could spare for it until I was able, on 9th August, to commence to send the MS. to the printers.

---

* Referred to in the synonymy as Eyferth's 'Naturgesch. mikr. Süsswass.,' the authors named above being the editors of the third edition of Eyferth's work (1900).

† In 'Mikr. Thierwelt Süsswassers,' 1886 and 1895.

In the meantime a sad event occurred. Mr. Cash was taken ill about the middle of January and died on the 20th of February. I had sent proofs of the plates to him early in that month, but believe that he was then too ill to look at them, and they lack the careful revision which they would doubtless have received from him; so also does the text.

I have only once met Mr. Cash. In June, 1908, he was staying at Criccieth and I at Capel Curig, North Wales, and one day we met by arrangement at Pont Aberglaslyn and had about an hour's walk and talk. It was then that we decided to conclude the present volume of the work with the Arcellida, and to leave the Conchulina Filosa to the third volume, the reasons for this being that so much work had to be done to that group that the issue of the present volume would be too greatly delayed, and that so much additional material had accumulated that the remainder of the Arcellida would make a volume equal in extent to the first volume and would require the same number of plates. It was then also that Mr. Cash first expressed his doubts as to the possibility of treating of the

Heliozoa, but as his reason was that he had so little material, I thought that by the time the third volume would be required many more species might be found, and urged him to continue to collect and record them. It was then also, seeing his method of collecting from sphagnous pools, that I commenced to collect.

It may be well to state here that nearly all the Freshwater Rhizopoda are so minute that they cannot be detected with a hand-lens, requiring a compound microscope for their detection as well as examination. The records to which no name is attached are those of Mr. Cash; nearly all others except published records are the result of the examination of material sent to him—that material being chiefly species of *Sphagnum* or of some other bog-moss. It was his intention to state this in his Preface to this volume.

Mr. Cash was a botanist as well as a zoologist, but as a sketch of his life is promised by Mrs. Cash for a future volume, it will be best to defer to that any appreciation of his scientific work. I wish however to express here my thanks to Mrs. Cash for her kindness in placing in my hands all her husband's manuscripts relating to the Rhizopoda (but mostly unintelligible, being in a shorthand of his own device), and also all his drawings of them; and for presenting to me recently a valuable collection of microscopic preparations of freshwater rhizopods made by Dr. Penard of Geneva and given to Mr. Cash by him.

I have also to thank Dr. Penard for adding to that collection, and for his kind assistance in reading the first proofs of this volume and making critical remarks which I have greatly appreciated and have made use of so far as was practicable in a text with the first proof set up in pages.

Advantage has been taken of a generous offer made by Professor G. S. West to select from his drawings any figures desired. Those which have been reproduced not only add to the attractiveness of the volume, but are also of interest as illustrating points alluded to in the text. Still more valuable for a future volume will be the rest, for they include some very beautiful coloured figures without which no more coloured plates could in all probability have been given, as there are none amongst Mr. Cash's own drawings.

An explanation remains to be made. The text of this volume so far as relates to the descriptions of the genera and species and also the remarks which follow, are as written by Mr. Cash, with the exception of additions placed within brackets [thus], and verbal alterations, including transpositions. A few localities have been added from published records and his own lists, the names of several species have been changed as indicated, and some of the dimensions have been revised when they did not coincide with those derived from a measurement of the figures. For the synonymy I am alone responsible, Mr. Cash's death having occurred whilst it was in preparation and therefore before it could be submitted to him, and although great care has been taken in its compilation, there will doubtless be found in it some cases of erroneous identification of critical species. It is not carried later than the year 1908.

JOHN HOPKINSON.

Weetwood, Watford,
25th October, 1909.

NOTE ON THE ILLUSTRATIONS.

The figures on all the plates in this volume, except Plates XXXI and XXXII, are photographic reproductions of drawings by Mr. Cash, and have been re-arranged since their receipt from him.

Most of the figures in the text have been selected from drawings by Mr. Cash, or by Prof. G. S. West (as stated); 21, stated to be "after" an author, have been photographed direct from published figures; 5 with a similar statement (figs. 46, 48–50, and 72) have been re-drawn by Mr. Cash; and 12 (figs. 52, 54, 61–64, and 105–110) have been similarly drawn by me.

All the illustrations, except the two lithographed plates named above, have been executed by Messrs. André and Sleigh, Ltd., of Bushey, Watford.

J. H.

CORRIGENDUM TO VOL. I.

Ouramœba vorax, p. 83.

It was the intention of Mr. Cash to state in the present volume that he had become convinced that the "non-contractile protoplasmic filaments," on the presence of which the genus *Ouramœba* was founded by Leidy, had been proved to be merely parasitic filamentous algæ, as in Penard's *Amœba nobilis* mentioned on p. 85. The genus therefore falls, and the species (*vorax*) may be only a form of *Amœba proteus*.

This question was discussed by Dr. Penard in 1902 in his 'Faune Rhiz. du Léman,' pp. 67–69, and again in 1905 in the 'Revue Suisse de Zool.,' vol. xiii, pp. 587–588.

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All measurements are expressed in micromillimetres (μ). $1\,\mu = 0{\cdot}001$ mm., or $0{\cdot}00003937$ in. ($\frac{1}{25400}$).

BRITISH

FRESHWATER RHIZOPODA.

[OWING to the discovery in Britain, since the first volume of this monograph was published, of Arcellida belonging to genera not then known to be represented in this country, the list of British genera of the Arcellida on page 37 of Vol. I requires revision. In their sequence, also, some changes have been made, and the list now stands as follows :—

A. *ARCELLINA:* (15) *Arcella*, (16) *Pseudochlamys*, (17) *Centropyxis*. B. *DIFFLUGINA:* (18) *Difflugia*, (19) *Pontigulasia*, (20) *Lesquereusia*, (21) *Phryganella*, (22) *Difflugiella*, (23) *Cryptodifflugia*. C. *NEBELINA:* (24) *Hyalosphenia*, (25) *Nebela*, (26) *Quadrula*, (27) *Heleopera*, (28) *Leptochlamys*, (29) *Cochliopodium*, (30) *Amphizonella*, (31) *Zonomyxa*.

The same re-arrangement is also required in the "Synopsis of the Genera" of the Arcellida on pp. 115–117 of Vol. I, and the following diagnoses of the genera now added are required to complete it :—

Test chitinous, compressed, smooth, usually with foreign particles; pseudopodia several, slightly ramifying, long and acutely pointed. 23. *Cryptodifflugia*.

Test membranous, thin and supple near the mouth, with a double marginal contour; plasma uninuclear; pseudopodia digitate and blunt. 30. *Amphizonella*.

Test pellicular, supple, roundish pyriform; plasma granular, multinuclear; pseudopodia simple, not digitate. 31. *Zonomyxa*.]

Order II. CONCHULINA.

Family 1. Arcellida (*continued*).

§ B. *Difflugina*.

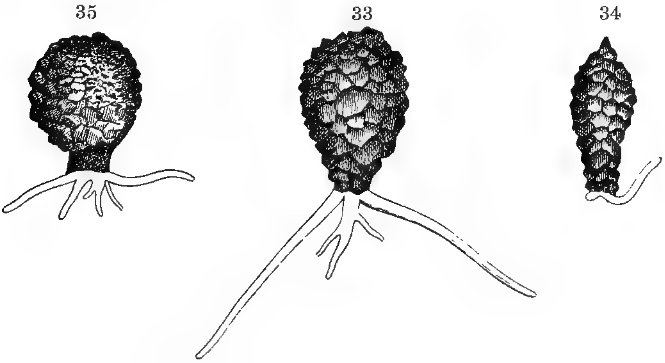
Genus 18. **DIFFLUGIA** Leclerc, 1815.

Difflugia Leclerc (pars) in Mém. du Mus. II (1815), p. 474, t. xvii.

Arcella Ehrenberg (pars) in Abth. Akad. Wiss. Berlin, 1841, p. 410.

Test varying from globular to elongated, pyriform, or acuminate, symmetrical in outline, and circular in transverse section (save in a few species which are more or less compressed or unsymmetrical); the crown conical, rounded, plain, or furnished with mamillary or linear protuberances. In structure variable, consisting (in most of the larger forms) of sand-grains, large and small, sometimes of diatom-frustules, agglutinated on a chitinous base; the mouth usually truncating a more or less distinct neck, its outline plain, crenulate, or lobed; the plasma occupying the greater part of the test and usually attached to the internal walls by threads of ectoplasm. The nucleus single (except in a few cases) and comparatively large, but obscured, in most forms, by the thickly-incrusted test; contractile vacuoles (one or more) situated in the upper region of the protoplasm, in proximity to the nucleus. Pseudopodia variable, two to six or (rarely) more, digitate, blunt, simple, knotted, or branched, usually consisting of colourless ectoplasm, but sometimes penetrated by the granular endoplasm.

[The genus *Difflugia* was founded by Leclerc in 1815 for two Rhizopods still retained in it and one since removed to *Lecquereusia*, a genus distinguished from *Difflugia* by Schlumberger in 1845 but included in it by Perty in 1852 and by Leidy in 1879. *Difflugia* has many species but is so well defined that very few have at any time been assigned erroneously to a different genus, perhaps only *D. constricta* and *D. globulus*, both of which Ehrenberg described as *Arcellæ*, the latter however with a query. Besides *Lecquereusia modesta* some other species first included in *Difflugia* are now considered to be generically distinct, forming the types of such genera as *Phryganella*, *Pontigulasia*, and *Trinema*, and in 1880 Vejdovský proposed to remove from it *Difflugia corona* under the name of *Corona cornula*.]



FIGS. 33–35.—*Difflugia* Leclerc: 33, *D. oblonga?*; 34, *D. acuminata*; 35, *Lesquereusia modesta*. After Leclerc, *loc. cit.*, ff. 3, 5, and 1 *a*. All × about 150.

This genus is more largely represented than any other in the rhizopodal life of our lakes and ponds. The tests vary in degree of opacity according as they are covered with extraneous matter or otherwise; generally they have a rough exterior, but forms are frequently met with in which the test, though opaque, is comparatively smooth, except for the presence of a few, and those generally large, scattered sand-grains. The varieties *lacustris* and *venusta* of *D. oblonga* Ehrenb. differ from the type in having a more or less transparent test composed of chitinous membrane with a surfacing of angular scales which vary in size and are probably siliceous.

1. **Difflugia oblonga** Ehrenberg.*

(Plate XVII, figs. 1–3, 7, and 8; Pl. XIX, figs. 3 and 4; and figs. 33 ?, 36, 37 ?, 38, and 39 in text.)

Difflugia oblonga Ehrenberg Infusionsth. (1838), p. 131, t. ii, f. 2 *a–d*; and in Abh. Akad. Wiss. Berlin, 1871 (1872), pp. 241, 256; Rymer Jones in Cyclop. Anat. IV, 29 (1847), p. 10, f. 7, no. 1; Hayek Handb. Zool. (1857), p. 42, f. 62; Stein in Carus' Icon. Zootom. I (1857), t. i, f. 58; Hogg Microscope, ed. 3 (1858), f. 162 B; ed. 15 (1898), f. 326 B; Claparède & Lachmann Études Inf. et Rhiz. 2 (1859), p. 448; Carter in Ann. Nat. Hist. (3) XIII (1864), p. 22; Archer in Q. Jrn. Micr. Sci. (n.s.) VIII (1868), p. 122; and in Jrn. Dublin Micr. Club, I, 3 (1868), p. 178; Carpenter, Microscope, ed. 5 (1875), f. 253 B; ed. 8 (1901), f. 579 B; Wythe Microscopist, ed. 3 (1877), pl. xii, f. 117 B; Lanessan in Rev. internat. Sci. VI (1880), p. 9; and Traité Zool., Prot. (1882), p. 52, f. 41; Parona in Boll. Scient. I, an. 4 (1882), pp. 52, 57; and in Arch. Sci. nat. (3) X (1883), p. 238; Phillips in Tr. Herts Nat. Hist. Soc. II, 3 (1883), p. 121; Claus Lehrb. Zool. ed. 2 (1883), f. 126 (p. 163); ed. 6, I (1904), f. 229 (p. 228); (Engl. transl.) Text-book Zool. I (1884), f. 126 (p. 186); (Fr. transl.) Traité Zool. (1884), ff. 201, 206 (pp. 199, 204); Zacharias in Biol. Centralbl. IX (1880), p. 58; Longi in Atti Soc. Ligust. III (1892), p. 145; *op. cit.* V (1894), p. 18; and VI (1895), p. 71.

Difflugia pyriformis Perty ? in Mitth. nat. Ges. Bern, 1849, p. 168; and Kenntn. kleinst. Lebensf. (1852), p. 187, t. ix, f. 9; Carter in Ann. Nat. Hist. (3) XII (1863), p. 249; and *op. cit.* (3) XIII (1864), p. 21, t. i, ff. 1–4; Archer in Q. Jrn. Micr. Sci. (n.s.) VI (1866), p. 186; and in Jrn. Dublin Micr. Club, I, 2 (1867), p. 51; Parfitt in Tr. Devon Assoc. III (1869), p. 66; Leidy (pars) in Pr. Acad. Philad. 1874, pp. 14, 79; *op. cit.* 1877 (1878), p. 307; 1879, p. 162; 1880, p. 338; 1881, p. 10; and Freshw. Rhiz. N. Amer. (1879), p. 98, t. x, ff. 1–16, 18–21, 26; t. xv, ff. 32, 33; t. xvi, f. 38; Nicholson Man. Zool. ed. 5 (1878), p. 63, f. 8; ed. 7 (1887), p. 77, f. 18; Bütschli in Bronn's Thier-Reichs, I, 1 (1880), t. iii, f. 6; Hitchcock Synops. Freshw. Rhiz. (1881), p. 12; Entz in Biol. Centralbl. II (1882), p. 451; Stokes in Amer. M. Micr. Jrn. III (1882), p. 93; Taránek in Sitzber. böhm.

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* See note on synonymy, Vol. I, p. 41.

Ges. Wiss. 1881 (1882), p. 227; De Tarr in Rep. N. York State Mus. XXXV (1884), p. 165; Blanc in Bull. Soc. Vaudois, (2) XX (1885), p. 288; in Ann. Nat. Hist. (5) XV (1885), p. 427; in Arch. Sci. nat. (3) XXVI (1891), p. 577 (?); and Difflugies Lac Léman (1892), p. 4, t. ii, ff. 11, 12; Wallich in Ann. Nat. Hist. (5) XVI (1885), p. 469, f. 3; Blochmann Micr. Thierw. Süsswass. (1886), p. 12, t. i, f. 20; and ed. 2 (1895), p. 16, t. i, f. 16; Bolton in Midl. Natur. IX (1886), p. 174; Lenderfeld in Pr. Linn. Soc. N. S. Wales, X (1886), p. 724; Ludwig in Leunis' Synops. Thierk. III, 2 (1886), p. 1170, f. 1157; Fielde in Pr. Acad. Philad. 1887, pp. 31, 122; Imhof in Zool. Anzeig. VIII (1885), p. 162; *op. cit.* XI (1888), p. 566; in Jahresb. nat. Ges. Graubünd. XXX (1887), p. 65 etc.; and in Arch. Sci. nat. (3) XXX (1893), p. 650; Whitelegge in Pr. Linn. Soc. N. S. Wales, (2) I (1887), p. 500; and in Jrn. R. Soc. N. S. Wales, XXIII, 2 (1889), p. 297; Carter in Amer. M. Micr. Jrn. IX, 1 (1888), p. 9; Guerne Excurs. Fayal et San Miguel (1888), pp. 32, 72; Harvey in Amer. Natur. XXII (1888), p. 72; Certes in Mission scient. Cap Horn, VI, 3, Prot. (1889), p. 12, t. i, f. 2; Penard in Jahrb. nassau. Ver. Naturk. XLII (1889), p. 44; *op. cit.* XLIII (1890), p. 70; in Mém. Soc. Genève, XXXI (1890), 2, p. 136, t. iii, ff. 30–38; in Amer. Natur. XXV (1891), p. 1071 etc.; in Arch. Sci. nat. (3) XXVI (1891), p. 143; *op. cit.* (4) VII (1899), pp. 90, 253, etc.; in Rev. Suisse Zool. VII, 1 (1899), p. 101 etc.; *op. cit.* VIII, 3 (1900), p. 481 etc.; Faune Rhiz. Léman (1902), p. 214, ff. 1–4, 7, 8 (p. 216); in Arch. Protist. II (1903), p. 255; in Pr. R. Soc. Edinb. XXV, 8 (1905), pp. 594, 599, etc.; and in Jrn. R. Micr. Soc. 1907, p. 277; Zacharias in Biol. Centralbl. IX (1890), p. 60 etc.; in Forschb. biol. Stat. Plön, I (1893), p. 3; and *op. cit.* II (1894), p. 57; Frenzel in Arch. mikr. Anat. XXXVIII (1891), p. 12; and in Bibl. Zool. IV, 12 (1897), p. 133, t. ix, ff. 3, 10; Lord in Sci. Goss. XXVII (1891), p. 132, ff. 91–94; and in Tr. Manch. Micr. Soc. 1891 (1892), p. 56; Rhumbler in Zeits. wiss. Zool. LII, 4 (1891), p. 518 etc.; and *op. cit.* LXI, 1 (1895), p. 38 etc., t. iv, ff. 15, 17; Cash in Tr. Manch. Micr. Soc. 1891 (1892), p. 48; Daday in Termés. Füzetek, XV (1892), p. 168 etc.; *op. cit.* XX (1897), p. 151 etc.; and XXI (1898), Suppl. pp. 6, 9; and in Sitzber. Akad. Wiss. Wien, CXII (1903), p. 140; Levander in Arch. Ver. Mecklenb. XLVI (1892), p. 114; in Acta Soc. Fauna

Fenn. XII (1894), 2, p. 13, t. i, f. 3; *op. cit.* XVIII (1900), 6, p. 21 etc.; XIX (1900), 2, p. 7 etc.; and XX (1901), 8, p. 7 etc.; SCHEWIAKOFF in Mém. Acad. Sci. St. Pétersb. (7) XLI (1893), 8, p. 6; BARROIS in Rev. biol. Nord France, VI (1894), p. 284; and in Mém. Soc. Sci. Lille, (5) VI (1896), pp. 59, 119, etc.; ZSCHOKKE in Verh. nat. Ges. Basel, XI, 1 (1895), p. 43 etc.; and in Arch. Hydrobiol. II, 1 (1906), p. 3; FRANCÉ in Res. wiss. Erforsch. Balatons. II (1897), 1, p. 8; FUHRMANN in Rev. Suisse Zool. IV (1897), p. 494 etc.; SCHAUDINN in Deutsch-Ost-Africa, IV, 2 (1897), 19, p. 9; SCOURFIELD in Pr. Zool. Soc. 1897, p. 787; HEMPEL in Bull. Illinois State Lab. V (1898), p. 319; STENROOS in Acta Soc. Fauna Fenn. XVII (1898), 1, p. 32 etc.; ZIMMER in Forschb. biol. Stat. Plön, VII (1899), p. 13; GODET in Bull. Soc. Neuchâtel, XXVIII (1900), p. 77; AVERINTZEV in Trudui S.-Peterb. Obshch. XXX, 1 (1900), p. 239; *op. cit.* XXXVI (1906), 2, p. 197; in Ber. Süsswass. nat. Ges. St. Petersb. I (1901), p. 212; and in Zool. Anzeig. XXXI (1907), pp. 244, 308; LAGERHEIM in Förh. Geol. Fören. Stockholm, XXIII (1901), p. 512 etc.; MARSSON in Forschb. biol. Stat. Plön, VIII (1901), p. 91 etc.; G. S. WEST in Pr. Linn. Soc., Zool. XXVIII (1901), p. 317; and in Ann. Scott. Nat. Hist. 1905, pp. 90, 92; ZYKOFF in Bull. Soc. Nat. Moscou, XVII (1903), 1, pp. 15, 107; in Zool. Anzeig. XXVII (1904), p. 390; and *op. cit.* XXIX (1906), p. 478; GOLDSMIDT in Arch. Protist. V, 1 (1904), p. 131; ZUELZER in Arch. Protist. V, 3 (1905), pp. 363, 368; CUSHMAN in Amer. Natur. XL (1906), p. 372; HARTOG Prot. in Cambr. Nat. Hist. I (1906), f. 10 D (p. 55); SCHORLER & THALLWITZ in Ann. Biol. Lacustre, I, 2 (1906), pp. 260, 286; SCHOUTEDEN in Ann. Biol. Lacustre, I, 3 (1906), pp. 343, 347, f. 17; THIEBAUD & FAVRE in Ann. Biol. Lacustre, I, 1 (1906), p. 76 etc.; BREHM in Arch. Hydrobiol. II, 4 (1907), p. 473; STEINMANN in Ann. Biol. Lacustre, II, 1 (1907), p. 38; HOOGENRAAD in Tÿdschr. Nederl. Dierk. Ver. (2) X, 4 (1908), p. 407; LANDACRE in Pr. Ohio Acad. Sci. IV, 10 (1908), p. 428; SCHNEIDER in Arch. Biontol. II, 1 (1908), p. 57.

Difflugia acuminata LEIDY (pars) ? Freshw. Rhiz. N. Amer. (1879), p. 109, t. xiii, ff. 3, 4.

Difflugia piriformis FOREL Faune Lacs Suisse (1885), p. 131; in Boll. Scient. III, an. 9 (1887), p. 90; and Le Léman, III (1904), p. 138; SACCHI in Boll. Scient. III an. 11 (1889), p. 68; and in Jrn. Microg. XIV (1890), p.

109; André in Jahresb. nat. Ges. Graubünd. XLI (1898), p. 57 etc.; Penard in Rev. Suisse Zool. XIII, 3 (1905), p. 596, t. xiii, ff. 12–14; and *op. cit.* XVI, 3 (1908), p. 402 etc.; Murray in Ann. Scott. Nat. Hist. 1907, p. 94.
Difflugia oblongata Butler in Handb. Dublin (Brit. Assoc. 1908), p. 219.

Test variable in outline and in size; typically oblong or pear-shaped; symmetrical, whether viewed longitudinally or transversely; the crown arched, sometimes furnished with a mamillary protuberance (Pl. XVII, fig. 8), the sides tapering with more or less convexity to the truncated mouth, or narrowed suddenly so as to form a short cylindrical neck. The surface incrusted with opaque sand-grains. The protoplasm granular, colourless, with a single nucleus in the posterior region, and three to six digitate, blunt, simple or sparingly-branched pseudopodia.

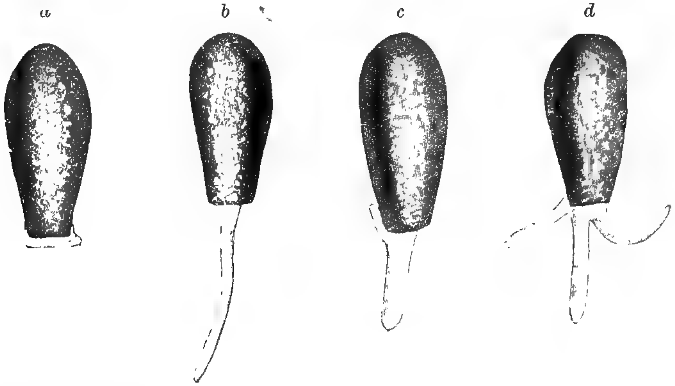

Fig. 36.—*Difflugia oblonga*: *a–d*, different aspects of test and states of activity of pseudopodia of the same individual. After Ehrenberg, *loc. cit.* (reduced). × 200.

Dimensions: Length from about 100 μ to 300 μ, or more; breadth 50–100 μ.

In the ooze of ponds, on the submerged stems and leaves of aquatic plants, and amongst the vegetation in swamps and marshy places; common and universally distributed.

Although this species is now almost universally called *Difflugia pyriformis*, Ehrenberg's name has the priority and must be adopted in accordance with the rules of zoological nomenclature. While there can moreover be no question as to the species being Ehrenberg's *Difflugia oblonga*, its identity with the *pyriformis* of Perty admits of doubt; indeed from its smooth outline, slender neck, and nearly regular markings, Perty's figure may represent a *Nebela*. [From the description, however—"Schale birnformig, manchmal unregelmässig; Textur grob"—it seems more probable that it is really a *Difflugia*, for the tests of the *Nebelæ* can scarcely be said to have a coarse texture. It was considered by Ehrenberg to be the same as his species, for he says: "Si reversa *D. oblonga* incrustatione detersa ex *D. pyriformis* oriretur quod Claparède et Lachmann nomen delendum esset." ('Abth. Akad. Wiss. Berlin,' 1871, p. 256.)]

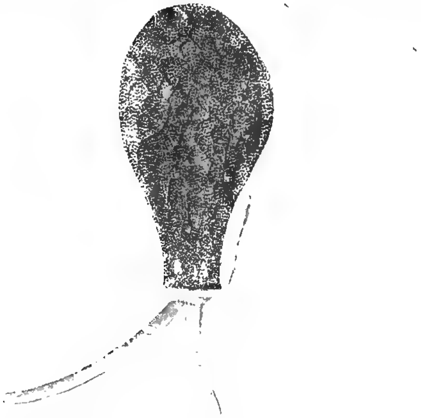

Fig. 37.—*Difflugia pyriformis* Perty: ? = *D. oblonga* Ehrenb. After Perty, *loc. cit.* × about 200.

Ehrenberg's name *proteiformis* has been adopted by some authors as covering the species now under consideration,* but, we think, without sufficient reason.

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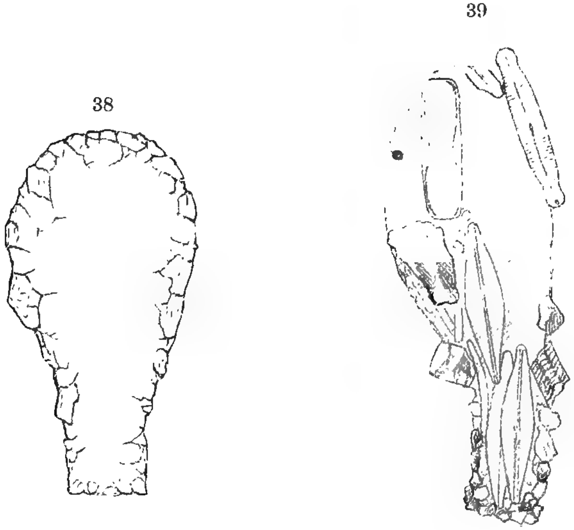
* [The identity of the forms thus named with *D. oblonga* is so doubtful that the references are omitted in the synonymy.]

The author of 'Infusionsthierchen' describes and figures them as distinct, though the incompleteness of his figures of *proteiformis* leaves it an open question as to what particular form that name was designed for. The uncertainty would have been obviated had the author figured the oral aperture. In that case—if we may judge from the general outline—in all probability one of the species with a lobate mouth (*e. g. D. lobostoma* Leidy) would rightly have borne the name *proteiformis* Ehrenb. In any case it cannot be accepted as a synonym for *D. oblonga* Ehrenb., and the safest course now is to discard the name *proteiformis* altogether.



Figs. 38 and 39.—*Difflugia oblonga*: 38, common form incrusted with sand-grains, × 200; 39, a peculiar form from Clapham, W. Yorks, chiefly incrusted with diatoms, × 310. The latter reduced from a drawing by G. S. West.

Examples are occasionally met with in which the test is in some degree compressed, and occasionally a want of bi-lateral symmetry is observable (fig. 39); whilst others have the crown peaked like a Gothic arch. These variations were regarded by Leidy as accidental, but their frequent recurrence justifies the conclusion that they point to some organic distinction; and Penard, with that insight which characterizes all his observations, has described several forms under varietal names. Between the pyriform and oblong examples of this variable species there are intermediate forms which cannot be classified. Those figured may be taken as showing the limits of variation in the species.

The largest examples of *D. oblonga* are found in the ooze of shallow pools. Those occurring in bogs and amongst *Sphagnum* are frequently dwarfed.

Var. **venusta** (Penard). (Plate XVII, figs. 4 and 5.)

Difflugia pyriformis var. *venusta* PENARD Faune Rhiz. Léman (1902), p. 220, f. 5 (p. 218); AVERINTZEV in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 300; SCHOUTEDEN in Ann. Biol. Lacustre, I, 3 (1906), pp. 342, 346.

Test in general outline resembling that of var. *claviformis*, but very much smaller and of different composition, being constructed of thin chitinous material, and semi-transparent, its surface covered with amorphous glossy scales. With a graceful outline and obtusely-pointed apex the sides swell outwards to the broadest diameter, thence (for about two-thirds of the length) taper more or less concavely downwards to the small truncated mouth. The protoplasm with nucleus and pseudopodia as in the type.

Dimensions: Average length 175 μ; breadth at broadest part 45–50 μ.

Ponds at Northenden and elsewhere in Cheshire, frequent. Pond at Chipperfield, Herts (*A. Earland*).

This is one of the most graceful of the smaller varieties of *D. oblonga* and perhaps the least abundant. It preserves its characters fairly constantly, but is somewhat variable in length. Usually it is associated with the preceding, and with *D. lanceolata* Penard, from which it may be distinguished by the subcylindrical lower portion of the test.

Var. **claviformis** (Penard). (Plate XVII, figs. 6 and 9.)

Difflugia pyriformis LEIDY (pars) Freshw. Rhiz. N. Amer. p. 98, t. x, f. 16.

Difflugia acuminata LEIDY (pars) Freshw. Rhiz. N. Amer. p. 109, t. xiii, ff. 3, 4.

Difflugia pyriformis var. *claviformis* PENARD in Rev. Suisse Zool. VII, 1 (1899), p. 25, t. ii, ff. 12–15; Faune Rhiz. Léman (1902), p. 219, ff. 3, 4 (p. 218); and Sarc. grands Lacs (1905), p. 19, f. (p. 20); AVERINTZEV in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, pp. 198, 201; SCHOUTEDEN in Ann. Biol. Lacustre, I, 3 (1906), pp. 342, 346; THIEBAUD & FAVRE in Ann. Biol. Lacustre, I, 3 (1906), pp. 76, 82; SCHNEIDER in Arch. Biontol. II, 1 (1908), p. 57.

Test large, comparatively smooth, opaque, subpyriform, the crown obtusely angular or terminated by a conical protuberance, the sides swelling outwards to the broadest diameter, thence curving downwards to the truncated mouth. Nucleus normally situated; the pseudopodia thick, blunt, branching from a mass of granular protoplasm issuing from the mouth of the test, sometimes knotted.

Dimensions: Length of test 390–435 μ; breadth 130–200 μ in broadest part.

Pond at Chelford, Cheshire. Pond at Chipperfield, Herts (*A. Earland*).

Penard describes and figures two forms of this variety —one (length 435 μ) with the crown tapering from the broadest diameter on each side convexly upwards to the obtuse apex; the other and smaller form (390 μ) with the apex rounded but terminating in a mamillary protuberance. The two forms occur together at Chipperfield, but having regard to the difference of outline, as well as of size, they might reasonably be regarded as distinct, the larger being true *claviformis*.

Var. **lacustris** (Penard). (Plate XIX, figs. 1 and 2; and fig. 40 in text.)

Difflugia pyriformis var. *lacustris* PENARD in Rev. Suisse Zool. VII, 1 (1899), p. 24, t. ii, f. 11; Faune Rhiz. Léman (1902), p. 222, f. 8 (p. 218); Sarc. grands Lacs (1905), p. 21, f. (p. 22); and in Pr. R. Soc. Edinb. XXV (1905), pp. 594, 597; AVERINTZEV in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 198; and in Zool. Anzeig. XXXI (1907), p. 244; SCHOUTEDEN in Ann. Biol. Lacustre, I, 3 (1906), p. 346; THIEBAUD & FAVRE in Ann. Biol. Lacustre, I, 1 (1906), pp. 76, 82; ZSCHOKKE in Arch. Hydrobiol. II (1906), p. 3; SCHNEIDER in Arch. Biontol. II, 1 (1908), p. 57.

Difflugia piriformis var. *lacustris* PENARD in Rev. Suisse Zool. XVI, 3 (1908), pp. 466, 468.

Test elongated, pyriform, or sub-cylindrical, slightly wider above than below, variable in length; composed of chitinous material with some incrustation of sand-grains (which are smallest about the mouth) in addition to angular siliceous scales, more or less transparent; the neck fortified by a ring of quartz-like particles, or a few of these only, irregularly disposed, and comparatively large, projecting outwards beyond the marginal line. The nucleus situated, as in other *Difflugiæ*, in the upper part of the body; the pseudopodia digitate, simple, not numerous.

Dimensions: Length 120–160 μ, or more.

In Cheshire ponds, frequent, along with the variety *venusta* and others. Probably very widely distributed. Pond at Chipperfield, Herts (*A. Earland*). Loch Ness, Scotland, in deep water (*G. S. West*).

This variety differs from others which have a semi-transparent chitinoid test in its elongated cylindrical or sub-cylindrical outline and uniformly arched crown, whilst its possession of large and prominent sand-grains, disposed in a ring about the neck, is a specially distinguishing feature. Penard ('Faune Rhiz. Léman,' p. 221) describes the var. *bryophila*, which is found amongst mosses in woods. It closely resembles var.

lacustris but is smaller and free from sand-grains, the test being thin and transparent.

The var. *lacustris* is not infrequently found in conjugation during the summer months. In Cheshire ponds it is frequently associated with the var. *venusta* Penard and with *D. lanceolata* Penard as well as with typical *D. oblonga* Ehrenb. and *D. acuminata* Ehrenb. Lacustrine forms described by Penard as occurring in Switzerland are more robust than our own; though an example from the Chipperfield pond was found to measure 260 μ.

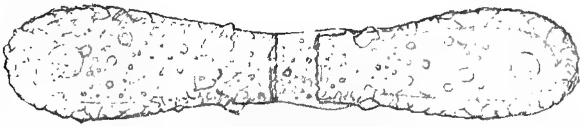


Fig. 40.—*Difflugia oblonga* var. *lacustris* in conjugation. × 200.

Difflugia oblonga var. *nodosa* (*D. pyriformis* var. *nodosa* Leidy, 'Freshw. Rhiz. N. Amer.,' p. 99, t. x, ff. 7–22) was originally described by Leidy as a distinct species under the name of *Difflugia entochloris*, but afterwards was admitted by him to be not specifically distinct from *D. pyriformis* (*oblonga* Ehrenb.). The test is more or less compressed, and is distinguished from other varieties by its broad and uneven crown, which is produced into "three knobs, or conical eminences, varying greatly in degree of development." It is found in ponds, according to Leidy, usually associated with the type, but so far as our observation extends, it is non-existent in this country. At first we were inclined to associate *D. crassa* sp. nov., from Chipperfield, with it, but a comparison of the figures shows that they are distinct.

2. **Difflugia crassa** *sp. nov.*

(Plate XVIII, figs. 1–3.)

Test large, composed of coarse sand-grains, dense and opaque; compressed, and very broad proportionately to the length, the crown arched and provided with two to four short mamillary protuberances, or conical blunt spines, which are not always symmetrically situated nor of uniform length. Pseudopodia massive, branching or lobed, and penetrated by the granular endoplasm. Nucleus normal.

Dimensions: Length (omitting the spines) 300–350 μ; breadth 250–300 μ.

In pond at Chipperfield, Herts, 1904 (*A. Earland*).

Examples from the locality above mentioned, gathered in the summer of 1904, were remarkable for the variations they presented no less than for their extraordinary size. In some individuals the diameter of the test was equal to about two-thirds of the length; others were nearly as broad as long; and the protuberances, which consisted of an agglomeration of coarse sand-grains, were arranged in a cruciform manner, one on the apex and one on each side of the test at its broadest part, whilst the neck varied, being in some examples shortly cylindrical, in others tapering downwards to the truncated mouth. A few examples met with were four-spined. In all cases the test, apart from the spines, was typically pyriform in broad lateral view; it was, however, more or less compressed in side view, and therefore, in transverse section, elliptic. In this latter respect it differs from all other forms of *D. oblonga* Ehrenb.

3. **Difflugia Penardi** *nom. nov.*[*]

(Plate XVIII, figs. 4–6.)

Difflugia proteiformis Ehrenberg (pars) ? Infusionsth. (1838), p. 131, t. ix, f. 1 *d*, *e*.

Difflugia globulosa Leidy (pars) Freshw. Rhiz. N. Amer. (1879), p. 96, t. xv, ff. 25, 26.

Difflugia fallax Penard (pars) in Mém. Soc. Genève, XXXI (1890), 2, p. 144, t. iv, ff. 41–43; in Amer. Nat. XXV

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[*] [*Difflugia fallax* Penard: Cash, MS. This name having since the death of Mr. Cash been found to be pre-occupied, that of the first describer of the species, Dr. Eugène Penard of Geneva, who has so thoroughly investigated the rhizopodal fauna of the Swiss lakes, is substituted for it.]

(1893), pp. 1071, 1072; in Arch. Sci. nat. (3) XXVI (1891), p. 143; in Rev. Suisse Zool. VII, 1 (1899), p. 35, t. ii, ff. 6–8; Faune Rhiz. Léman (1902), p. 245, ff. 1–7 (p. 246); and in Arch. Protist. II (1903), p. 256; AVERINTZEV in Ber. Süsswass. nat. Ges. St. Pétersb. I (1901), p. 211; in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 203; and in Zool. Anzeig. XXXI (1907), pp. 244, 308; LAGERHEIM in Förh. Geol. Fören. Stockholm, XXIII (1901), p. 511; FOREL Le Léman (1904), III, p. 138; SCHOUTEDEN in Ann. Biol. Lacustre, I, 3 (1906), pp. 344, 347; THIEBAUD & FAVRE in Ann. Biol. Lacustre, I, 1 (1906), pp. 70, 76; ZSCHOKKE in Arch. Hydrobiol. II, 1 (1907), p. 3.

(Non *Difflugia fallax* EHRENBERG in Abh. Akad. Wiss. Berlin, 1871 (1872), p. 252, t. ii, 1, f. 19.)

Test short, with a semi-circular dome, and wider in proportion to the length than *D. oblonga* var. *lacustris*, which in some respects it resembles; tapering convexly downwards from the crown to the truncated mouth; thin in texture; usually studded with diatom-frustules, but frequently incrusted with minute sand-grains. Pseudopodia few, digitate; nucleus normal.

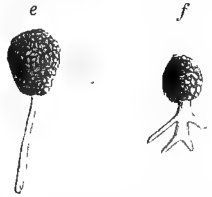


FIG. 41.—*Difflugia proteiformis* Ehrenb. (pars). ? = *D. Penardi.* After Ehrenberg *loc. cit.* (reduced). × 250.

Dimensions: Length 60–85 μ; breadth about 30 μ.

Amongst *Sphagnum* in boggy ground. Cheshire and Carnarvonshire. Summit of Ben Ledi, Scotland (*W. Evans*). Killough, Co. Wicklow, Ireland (*J. Hopkinson*).

The test of this small species is semi-transparent, and from the presence of diatoms in its structure, might (at any rate as to the larger forms) be mistaken for *D. bacillifera* Penard. It, however, does not possess the long neck characteristic of that species. The limits of these forms are often difficult to determine. They are very variable. *D. Penardi* seems sufficiently distinct in its general features to rank as a species. In length it is about half the average measurement of *D. oblonga* var. *lacustris*, and it has a narrower mouth.

[The small forms of Ehrenberg's *Difflugia proteiformis* (fig. 41) appear to resemble this species more closely than any other.]

4. [?] **Difflugia pulex** Penard.

(Plate XVIII, figs. 7 and 8.)

Difflugia pulex Penard Faune Rhiz. Léman (1902), p. 229, ff. 1–8 (p. 230); Averintzev in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 196; Schouteden in Ann. Biol. Lacustre, I, 3 (1906), pp. 343, 346.

Test smaller than that of the preceding species, oval, tapering suddenly into a short neck, the mouth truncated. Substance of the test thin, semi-transparent and yellowish, or covered with small sand-grains. Pseudopodia variable; the nucleus single, but owing to the opacity of the test usually invisible.

Dimensions : Length 65–70 μ; breadth 40–45 μ.

In similar situations to the preceding. Chelford, Cheshire; Dolgoch, Merionethshire; Sychnant Pass, Carnarvonshire. Bricket Wood Common, Herts; Moel Siabod and Nant Francon, N. Wales; Calary Bog, Co. Wicklow, Ireland (*J. Hopkinson*).

Examples met with in the above localities correspond with Penard's description and figures, but they are invariably incrusted with sand-grains or other extraneous material, and opaque. We have not met with any showing the yellowish chitinoid test which seems to be a feature of the continental forms. [Those also being much smaller, usually 22–25 μ and never exceeding 30 μ in length, the identification of the species is doubtful.]

5. **Difflugia bacillifera** Penard.

(Plate XX, fig. 1.)

Difflugia pyriformis Leidy (pars) Freshw. Rhiz. N. Amer. (1879), p. 103, t. x, f. 22.
Difflugia bacillifera Penard in Mém. Soc. Genève, XXXI (1890), 2, p. 146, t. iv, ff. 61–66; in Amer. Natur. XXV (1893), p. 1079; in Arch. Sci. nat. (4) VII (1899), p. 257; and Faune Rhiz. Léman (1902), p. 230, ff. 1–4 (p. 231); Rhumbler in Zeits. wiss. Zool. LXI, 1 (1895), p. 76, t. iv, f. 20; Levander in Acta Soc. Fauna Fenn. XVIII (1900), 6, p. 72 etc.
Difflugia pyriformis var. *bacillifera* Levander in Acta Soc. Fauna Fenn. XII (1895), 2, p. 14.
Difflugia septentrionalis var. *bacillifera* Averintzev in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 209. (*Cf.* Schouteden in Ann. Biol. Lacustre, I (1906), p. 347.)

Test variable in form, usually ovoid above, with a rounded semi-circular crown, tapering below into a narrow, often cylindrical neck, and covered wholly or in part with diatom-frustules intermixed with scattered sand-particles. Nucleus single; pseudopodia normal.

Dimensions: Length 145–160 μ.

In *Sphagnum*-pools. Delamere, Cheshire; Tan-y-Bwlch, N. Wales. Moel Siabod, Nant Francon, and above Dolgam, Capel Curig, N. Wales; Calary Bog, Co. Wicklow, Ireland (*J. Hopkinson*).

This form is covered always in a greater or less degree with diatoms gathered from the water in which it exists—*Naviculæ*, *Pinnulariæ*, etc.—and by its broadly-rounded crown and tubular neck is readily distinguished from others which have their tests similarly invested. Penard finds in continental examples a further peculiarity, namely, the formation round the mouth of a ring of green particles, resembling minute algæ, but we cannot say that we have observed these. It is a variable species, however. In *Sphagnum* from Capel Curig, gathered by Mr. Hopkinson in the summer of 1908, examples were found so thickly incrusted with diatom-frustules as to leave little or none of the natural surface of the chitinous test visible. The frustules were destitute of colouring matter.

6. **Difflugia pristis** Penard.

(Plate XVIII, figs. 9–11.)

Difflugia fallax PENARD (pars) in Mém. Soc. Genève, XXXI (1890), 2, p. 144, t. iv, ff. 45–51?

Difflugia pristis PENARD Faune Rhiz. Léman (1902), p. 254, ff. 1–7; AVERINTZEV in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 208; SCHOUTEDEN in Ann. Biol. Lacustre, I, 3 (1906), pp. 344, 347.

Test ovoid, very regular, variable in length, which is generally about equal to twice the breadth; the mouth contracted, terminal, and relatively small. Pseudopodia thin, numerous, mobile, not branching.

Dimensions: Length 60–65 μ; breadth 30–35 μ.

On submerged vegetation, Hill Cliff reservoir, near Warrington. Loch Ness, Scotland (*D. J. Scourfield*).

This organism agrees with Penard's description in 'Faune Rhizopodique du Bassin du Léman' except in one respect, namely, that instead of being "blackish" and opaque, the tests of all the individuals we examined from the Hill Cliff locality were membranous, carrying on their exterior a few scattered sand-grains mixed with thin scale-like particles, and not so dense as to prevent the plasma from being distinctly seen. This may have been caused by their living amongst floating vegetation in clear water, and not on the muddy bottom. Having regard to the dimensions of the organism, and the character and movements of the pseudopodia, they could not be referred to any other species than *D. pristis* Penard.

7. **Difflugia petricola** *sp. nov.*

(Plate XIX, figs. 5–7.)

Test spherical, with a short, cylindrical, or slightly-swollen neck; incrusted with large angular sand-grains which give it a rugged outline, the neck only being composed of fine particles and comparatively smooth. Neck tubular and slightly contracted at the mouth which has a sharply-defined outline.

Dimensions: Diameter of test about 80 μ; length of neck 25–30 μ, its width 20 μ.

In Dunham Marsh, Cheshire, amongst *Sphagnum* and other mosses in very wet ground, 1903.

This is so distinct a form, and apparently so little subject to variation, that one has little difficulty in claiming it as a species. In the autumn of 1903 empty tests occurred abundantly in squeezings of *Sphagnum* and other sub-aquatic mosses which had been kept too long before examination. Living examples were not found, and the organism up to the time of writing has not since been met with.

The incrustation of the tests was extraordinary; large angular sand-grains were agglutinated together so that each test was more heavily weighted than is usual with *Difflugiæ*; and they were quite opaque. The finely-moulded short neck was characteristic; no other species has one quite like it. A unique example was observed of a double test, as though an individual had annexed its neighbour, producing a form which looked like a test with two necks and two apertures.

This singular *Difflugia* occurred in spongy ground overgrown with mosses and other vegetation amongst which was abundance of *Utricularia minor*. Associated with it was *Lesquereusia inæqualis* sp. nov. and *L. epistomium* Penard.

8. **Difflugia acuminata** Ehrenberg.

(Plate XVIII, figs. 12 and 13; and figs. 34 and 42–44 in text.)

Difflugia acuminata Ehrenberg Infusionsth. (1838), p. 131, t. ix, f. 3; Dujardin Infus. (1842), p. 249, f. 5; Pritchard Hist. Infus. (1842), p. 168; ed. 4 (1861), p. 553; Perty Kenntn. kleinst. Lebensf. (1852), p. 187; Cole in Pr.

Essex Inst. (U.S.A.) I (1853), p. 45; Claparède & Lachmann Études Inf. et Rhiz. 2 (1859), p. 447; Leidy (pars) in Pr. Acad. Philad. 1874, pp. 14, 79; *op. cit.* 1877 (1878), p. 307; 1879, p. 162; 1881, p. 9; and Freshw. Rhiz. N. Amer. (1879), p. 109, t. xiii, ff. 1, 2, 5–7, 9–11, 16–22; Mereschowsky in Arch. mikr. Anat. XVI, 2 (1878), p. 113, t. i, ff. 16, 17; Bütschli in Bronn's Thier-Reichs, I, 1 (1880), t. iii, f. 7; Hitchcock Synops. Freshw. Rhiz. (1881), p. 13; Taránek in Sitzber. böhm. Ges. Wiss. 1881 (1882), p. 227; Parona in Arch. Sci. nat. (3) X (1883), p. 238; De Tarr in Rep. N. York State Mus. XXXV (1884), p. 166; Daday in Ertez. math. termész. Akad. Budapest, III (1885), p. 161; in Termész. Füzetek, XIV (1891), p. 110; *op. cit.* XX (1897), p. 151 etc.; XXI (1898), pp. 6, 9; and in Sitzber. Akad. Wiss. Wien, CXII, 1 (1903), p. 140; Forel Faune Lacs Suisse (1885), p. 131; in Boll. Scient. III, an. 9 (1887), p. 90; and Le Léman, III (1904), p. 138; Blochmann Mikr. Thierw. Süsswass. (1886), p. 13, t. i, f. 21; and ed. 2 (1895), p. 16, t. i, f. 18; Bolton in Midl. Natur. IX (1886), p. 174; Fielde in Pr. Acad. Philad. 1887, p. 122; Imhof in Jahresb. nat. Ges. Graubünd. XXX (1887), p. 103; in Zool. Anzeig. XI (1888), p. 566; and in Arch. Sci. nat. (3) XXX (1893), p. 649; Whitelegge in Pr. Linn. Soc. N. S. Wales, (2) I (1887), p. 500; and in Jrn. R. Soc. N. S. Wales, XXIII, 2 (1889), p. 298; Guerne Exc. zool. Fayal et San Miguel (1888), pp. 31, 72; Sacchi in Boll. Scient. III, an. 10 (1888), p. 44; and in Jrn. Microgr. XII (1888), p. 347; Certes in Mission scient. Cap. Horn, VI (1889), 3, Prot., p. 13; Penard in Jahrb. nassau. Ver. Naturk. XLII (1889), p. 144; *op. cit.* XLIII (1890), p. 79; in Mém. Soc. Genève, XXXI (1890), 2, p. 139, t. iii, f. 54; in Arch. Sci. nat. (4) VII (1899), p. 251 etc.; Faune Rhiz. Léman (1902), p. 233, ff. 1, 2, 11; in Pr. R. Soc. Edinb. XXV, 8 (1905), p. 599; and in Rev. Suisse Zool. XVI, 3 (1908), p. 462; Gruber in Zacharias' Tierw. Süsswass. (1891), I, p. 139, f. 16 (2); Lord in Sci. Goss. XXVII (1891), p. 133, ff. 100–103; and in Tr. Manch. Micr. Soc. 1891 (1892), p. 55; Rhumbler in Zeits. wiss. Zool. LII, 4 (1891), p. 518 etc., t. xxxii, ff. 4–9, 11, and text-ff. 1, 13; and *op. cit.* LXI, 1 (1895), p. 43, t. iv, f. 10; Cash in Tr. Manch. Micr. Soc. 1891 (1892), p. 48; Levander (pars) in Arch. Ver. Mecklenb. XLVI (1892), p. 114; in Acta Soc. Fauna Fenn. XII (1894), 2, p. 15, t. i, f. 7; *op. cit.* XVIII (1900), 6, p. 21 etc.; XIX (1900), 2, p. 13; and XX (1901), 8, p. 12; LONGHI in Atti Soc. Ligust. III (1892), p. 145; SCHEWIAKOFF in Mém. Acad. St. Pétersb. (7), XLI (1893), 8, p. 98; ZACHARIAS in Forschb. biol. Stat. Plön, I (1893), p. 3; and *op. cit.* II (1894), p. 57; ZSCHOKKE in Verh. nat. Ges. Basel, XI, 1 (1895), p. 43 etc.; BARROIS in Mém. Soc. Sci. Lille, (5) VI (1896), p. 118 etc.; FRANCÉ in Res. wiss. Erforsch. Balatons. II (1897), 1, pp. 3, 8; FUHRMANN in Rev. Suisse Zool. IV (1897), p. 491 etc.; SCHAUDINN in Deutsch-Ost-Africa, IV, 2 (1897), 19, p. 9; ANDRÉ in Jahresb. nat. Ges. Graubünd. XLI (1898), pp. 58, 59; HEMPEL in Bull. Illinois State Lab. V (1898), p. 319; STENROOS in Acta Soc. Fauna Fenn. XVII (1898), 1, p. 33 etc.; AVERINTZEV in Trudui S.-Peterb. Obshch. XXX, 1 (1900), p. 239; *op. cit.* XXXVI (1906), 2, p. 192; and in Ber. Süsswass. nat. Ges. St. Petersb. I (1901), p. 212; GODET in Bull. Soc. Neuchâtel, XXVIII (1900), p. 77; LAGERHEIM in Förh. Geol. Fören. Stockholm, XXIII (1901), p. 509 etc.; G. S. WEST in Jrn. Linn. Soc., Zool. XXVIII (1901), p. 319; KOFOID in Bull. Illinois State Lab. VI, 2 (1903), p. 526; ZYKOFF in Bull. Soc. nat. Moscou, XVII (1903), p. 15; FOREL Le Léman, III (1904), p. 138; GOLDSMIDT in Arch. Protist. V, 1 (1904), p. 131; SCHORLER & THALWITZ in Ann. Biol. Lacustre, I (1906), pp. 260, 286; SCHOUTEDEN in Ann. Biol. Lacustre, I, 3 (1906), pp. 343, 346; THIEBAUD & FAVRE in Ann. Biol. Lacustre, I, 1 (1906), p. 76 etc.; BREHM in Arch. Hydrobiol. II, 4 (1907), p. 473; SCHNEIDER in Arch. Biontol. II (1908), 1, p. 57.

Difflugia acaulis PERTY in Mitth. nat. Ges. Bern, 1849, p. 167.

Difflugia acuminata var. *acaulis* PERTY Kenntn. kleinst. Lebensf. (1852), p. 186, t. ix, f. 6; LONGI in Atti Soc. Ligust. III (1892), p. 145; and *op. cit.* V (1894), p. 19.

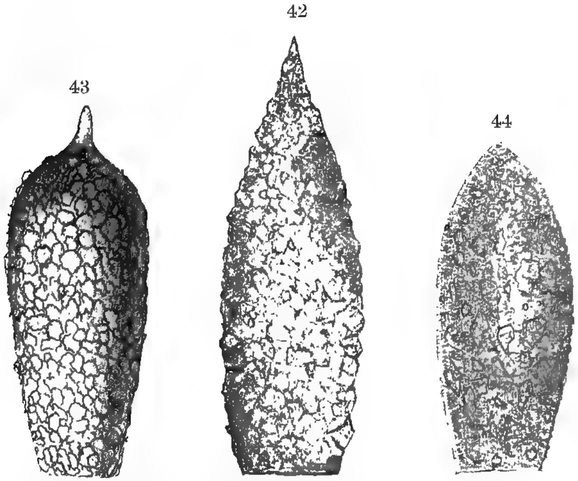
Difflugia mitriformis var. *acuminata* WALLICH in Ann. Nat. Hist. (3) XIII (1864), p. 240, t. xv, ff. 3 *a–c*; t. xvi, f. 11.

Test usually oblong, oval, pyriform, or sub-cylindrical, somewhat enlarged posteriorly; three to four times longer than broad; the crown tapering or acuminate; the neck narrowing slightly to a rather wide circular mouth. Surface of the test rarely smooth, more frequently carrying an incrustation of sand-grains, occasionally with diatoms intermixed. Protoplasm colourless; nucleus and pseudopodia as in the allied species.

Dimensions variable ; length from about 100 μ up to 300 μ, or more ; breadth 35–95 μ.

In the ooze of sands and in marshy ground, usually associated with *D. oblonga* Ehrenb., and nearly as common. Glyder Fach, N. Wales, up to 2200 ft. (*G. S. West*). Moel Siabod, N. Wales, at 2500 ft. (*J. Hopkinson*).

This species is about as variable as *D. oblonga* Ehrenb. Ehrenberg's name was given to the common large form, which has a nearly cylindrical test, slightly enlarged posteriorly, and is three to four times longer than broad, with an acute apex. Between this—which may be regarded as typical—and the smaller varieties, there is a large gradation of forms, some with two or more points. The dimensions of these abnormal forms, which can hardly be regarded as permanent varieties, vary considerably.



Figs. 42–44.—*Difflugia acuminata* Ehrenb. showing great variation. × 200. Fig. 42.—From pond at Chipperfield, Herts. Fig. 43.—After Ehrenberg, *loc. cit.* (reduced). Fig. 44.—Var. *acaulis* Perty. After Perty, *loc. cit.*

Var. **inflata** Penard. (Plate XVIII, fig. 14.)

Difflugia proteiformis var. *acuminata* Wallich in Ann. Nat. Hist. (3) XI (1863), p. 453, t. x, f. 13.

Difflugia acuminata Leidy (pars) Freshw. Rhiz. N. Amer. (1879), p. 109, t. xiii, ff. 2, 5, 14; Levander (pars) in Acta Soc. Fauna Fenn. XII (1894), 2, p. 15, t. i, f. 9; Averintzev (pars) in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 193.

Difflugia acuminata var. *amphora* Penard in Mém. Soc. Genève, XXXI (1890), 2, p. 139, t. iii, ff. 55–63; G. S. West in Jrn. Linn. Soc., Zool. XXIX (1903), p. 113.

Difflugia acuminata var. *inflata* Penard in Rev. Suisse Zool. VII, 1 (1899), p. 29, t. iii, f. 1; Faune Rhiz. Léman (1902), p. 234, f. 10 (p. 233); in Pr. R. Soc. Edinb. XXV, 8 (1905), p. 594; and Sarc. grands Lacs (1905), p. 14, f. (p. 15); Schouteden in Ann. Biol. Lacustre, I, 3 (1906), p. 346; Zschokke in Arch. Hydrobiol. II, 1 (1906), p. 3.

Test of thin chitinous material, incrusted with sandy and muddy particles; shorter than the type and broader in proportion, the breadth being little more than half the average length, swollen above and suddenly contracted towards the acute or conical apex, which is sometimes furnished with a tubular horn; the structure, in its lower half, narrowed convexly downwards to the truncated mouth, which is neither expanded nor urceolate. Nucleus and pseudopodia normal — the latter usually long.

Dimensions: Length 230–250 μ.

In bog-pools. Giggleswick, West Yorkshire (*G. S. West*). Sychnant Pass, Carnarvonshire, 1907. Loch Ness, Scotland (*D. J. Scourfield*).

This distinct form, described by Penard in 'Faune Rhizopodique du Bassin du Léman' (1902) under the name here given, is the var. *amphora* of his 'Études sur les Rhizopodes d'eau douce' (1890). The latter name had previously been given by Leidy (1879) to a form of *D. urceolata* Carter. The variety *inflata* is very scarce, according to our experience, in Britain.

Var. **curvata** *var. nov.* (Plate XXI, figs 1 and 2.)

Test pyriform, curved, with a short cylindrical neck, and a blunt mamillary protuberance on the crown; its two sides (as seen in one aspect) unequally convex; the pronounced curvature of the test produced by the outer surface from the crown downwards, for about three-fourths of the total length, being broadly convex whilst the opposite side is convex for only one half the total length, or less, and then carried downwards, concavely in outline, so as to form the narrow neck. (In another aspect of the test—that is, viewed with the broader convex surface towards the eye—the sides appear straight and approach each other gradually till they reach the abruptly-truncated mouth. In this aspect, moreover, the crown has a tendency towards the acuminate form, though the shell is not in the least compressed, and the coronal protuberance is slightly deflected from the longitudinal axis.) External surface overlaid with muddy particles, and opaque; consequently the protoplasmic contents of the test are invisible. Pseudopodia normal, few in number.

Dimensions : Length 240 μ; breadth 110 μ.

In pond at Chipperfield, Herts, 1904 (*A. Earland*).

This variety seems to be peculiar to the Chipperfield pond. A considerable number of individuals and some empty tests were examined and all exhibited the same remarkable curvature.

The coarser *Difflugiæ* exist in this pond in great abundance.* The quality of the water, the nature of the soil, or some other cause unknown, appears to favour their growth and development. The variety under notice occurs in association with *D. oblonga* Ehrenb., *D. crassa* sp. nov., *D. urceolata* Carter, *Lesquereusia modesta* Rhumbler, and other species.

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* [A small pond overgrown with rushes, on the south edge and near the east end of Chipperfield Common.]

9. **Difflugia bacillariarum** Perty.

(Figs. 45–47.)

Difflugia bacillariarum PERTY in Mitth. nat. Ges. Bern, 1849, p. 27; and Kenntn. kleinst. Lebensf. (1852), p. 187, t. ix, f. 7; CLAPARÈDE & LACHMANN Études Inf. et Rhiz. I, 2 (1859), p. 448.

Difflugia elegans PENARD (pars) in Mém. Soc. Genève, XXXI (1890), 2, p. 140, t. iv, ff. 4, 5, 11; Faune Rhiz. Léman (1902), p. 236, ff. 12, 13 (p. 237).

Difflugia acuminata var. *elegans* G. S. WEST in Jrn. Linn. Soc., Zool. XXVIII (1901), p. 319, t. xxviii, ff. 11, 12.

Difflugia Solowetzkii G. S. WEST in Jrn. Linn. Soc., Zool. XXIX (1903), p. 113; AVERINTZEV (pars) in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 189. (Non *D. Solowetzkii* MERESCHKOWSKY in Arch. mikr. Anat. XVI (1878), p. 194, t. x, f. 17.)

Test chitinous, transparent, covered, as a rule, with minute diatom-frustules and some sand-grains, scattered or aggregated; broad in proportion to its length, and symmetrical, at the mouth about two-thirds the width at its broadest part; the convex sides sloping evenly downwards from the crown, without constriction or dilation; the acute or conical crown terminated by a protuberance which is erect or deflected at an angle, hollow and frequently perforated at the apex. Nucleus and pseudopodia normal; the latter usually simple.

Dimensions: 94–100 μ (*West*).

Wicken Fen, Cambs; Llyn-y-cwm-ffynon, N. Wales; and Rhiconich, Sutherlandshire (*G. S. West*).

Difflugia bacillariarum (first described by Perty under this name in 1849) is a variable species, making with its variety *elegans* (*Difflugia elegans* Penard) a group of forms as difficult to determine as are the multitudinous forms of *D. constricta.* Those which are comprehended under the variety *elegans* have one feature which is rarely absent—the test has a slight constriction above the mouth, causing that to appear dilated.

We have included in typical *bacillariarum* the form described by Dr. G. S. West in the 'Journal of the Linnean Society' on account of its having the test broad and symmetrical (though the coronal horn is deflected) and its anterior part without constriction. It has peculiarities, however, in the clear chitinous and homogeneous test and the absence of minute diatoms such as Perty represents adhering to it; but there is nothing in these characters which may not be accounted for by environment. In the swamp at Dunham, Cheshire, we have met with a form not unlike West's, but with an erect rounded protuberance on the crown instead of a tubular horn—a fact which, no less than its general variability, leads us to doubt whether the posterior perforation—when present—plays any practical part in the economy of the organism. If it did we might expect it to be an unvarying feature.

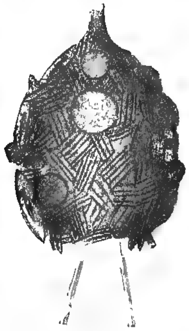

FIG. 45.—*Difflugia bacillariarum.* After Perty, *loc. cit.* × about 280.

West describes the form which he discovered in Wales as possessing a pale yellow test, through which the protoplasm was distinctly visible; its body had scattered sand-grains attached, comparatively large, and similar grains agglomerated about the mouth. In the 'Journal of the Linnean Society (Zool.),' vol. xxix, p. 113, the author correlated this form with *Difflugia Solowetzkii* Meresch., and gave another locality for it—in Sutherlandshire. The figure of

D. Solowetzkii, however, which is given by Mereschkowsky in 'Arch. f. mikr. Anat.' XVI (1878), t. x, f. 17, represents a test perfectly symmetrical, with a conical crown (no posterior tube), thickly incrusted with sand-grains, and entirely opaque. It is contracted below as in *D. bacillariarum* var. *elegans*, and the lips of the dilated orifice are recurved, and rough with adhering sand-grains, the basal outline being convex. Judging from the figures (we have had no opportunity of examining the actual tests), this and Penard's *D. elegans* var. *teres* (' Sarc. des grands Lacs ' [1905] p. 16) seem to be identical. No example which could safely be referred to either of these forms has yet been met with in Britain. They would rank under this classification as *D. bacillariarum* var. *Solowetzkii*.*

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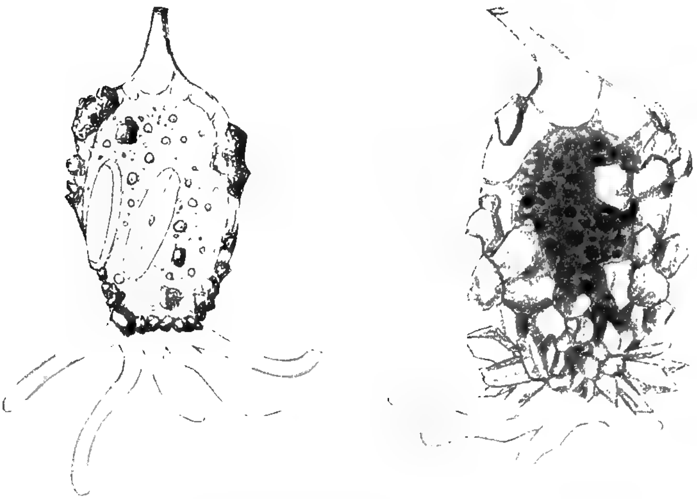

FIGS. 46 AND 47.—*Difflugia bacillariarum*. After G. S. West (as *D. acuminata* var. *elegans*). Fig. 46 from Wicken Fen, Cambs. × 340. Fig. 47 from Llyn-y-cwm-ffynon, N. Wales. × 520.

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* [It seems probable, however, that Penard's var. *teres* is a distinct variety more nearly related to var. *elegans* than to var. *Solowetzkii* (see figs. 48–50).]

Var. **elegans** (Penard). (Plate XX, figs. 2–5; and fig. 48 in text.)

Difflugia acuminata Leidy (pars) Freshw. Rhiz. N. Amer. p. 111, t. xiii, ff. 23–26; Rhumbler (pars) in Zeits. wiss. Zool. LII, 4 (1891), t. xxxii, f. 8.

Difflugia elegans Penard (pars) in Mém. Soc. Genève, XXXI (1890), 2, p. 140, t. iv, ff. 7, 8; in Jahrb. nassau. Ver. Naturk. XLIII (1890), p. 70; in Arch. Sci. nat. (3), XXVI (1891), p. 143; *op. cit.* (4) VII (1899), p. 251 etc.; in Rev. Suisse Zool. VII, 1 (1899), p. 100, t. ix, ff. 13–15; and Faune Rhiz. Léman (1902), p. 236, ff. 1–7, 9, 11 (p. 237); Rhumbler (pars) in Zeits. wiss. Zool. LXI, 1 (1895), p. 44, t. iv, ff. 9, 11, 16, 19; Prowazek (pars) in Arb. zool. Inst. Wien, XII, 3 (1900), p. 251 etc., t. i, ff. 7, 8; Forel Le Léman (1904), III, p. 138; Schneider in Arch. Biontol. II, 1 (1908), p. 58.

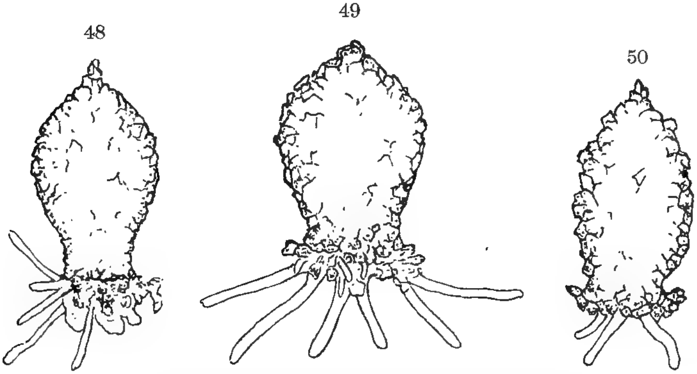
Difflugia Solowetzkii Averintzev (pars) in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 189; Schouteden (pars), in Ann. Biol. Lacustre, I, 3 (1906), pp. 342, 345.

Test chitinous, transparent, very variable, with a rounded, acuminate or irregularly-formed crown, terminated by a hollow horn-like tube, which is erect or curved, and sometimes (by no means always) perforated at the apex; sides more or less curved, and inflated below the crown, frequently unsymmetrical, and constricted to a greater or less degree immediately above the mouth, of which the margin is not recurved; covered with minute elongated or rod-like diatom-shells, some of which are attached by their extremities and stand out at varying angles, rarely with larger *Naviculæ*. The living organism distinctly visible through the scales of the test, showing the cavity to be about three-fourths occupied; the body containing granular matter, and chlorophyllous pellets rather sparingly, and a single comparatively large nucleus. Pseudopodia simple, not numerous, thrust outwards through a mass of loose sandy particles, which nearly always surround the orifice.

Dimensions: Length 100–120 μ.

In bog-pools in Delamere Forest, Dunham, and elsewhere in Cheshire; frequent in North Wales.

This variety comprehends a number of forms, all of which possess the characters specified, with, however, some modifications. Those incrusted with sand-grains, some of which are figured by Penard ('Faune Rhiz. Leman,' p. 237) may belong to the var. *Solowetzkii.* It is desirable to confine var. *elegans* to those which have a chitinous test, are diatom-covered, and more or less transparent. Wherever the organism occurs it is usually plentiful, and individuals inhabiting the same water, and even the same drop, exhibit a remarkable range of forms.



FIGS. 48–50.—Varieties of *Difflugia bacillariarum.* Fig. 48.—Var. *elegans.* After Penard (as *Difflugia elegans*) 'Faune Rhiz. Léman,' p. 237, fig. 1. Fig. 49.—Var. *teres.* After Penard (as *D. elegans* var. *teres*) 'Sarc. grands Lacs,' p. 16. Fig. 50.—Var. *Solowetzkii.* After Mereschkowsky (as *D. Solowetzkii*) in 'Arch. mikr. Anat.' XVI, t. x, f. 17. All × about 280.

10. [?] **Difflugia curvicaulis** Penard.

(Plate XIX, fig. 8.)

Difflugia curvicaulis PENARD in Rev. Suisse Zool. VII, 1 (1899), p. 36, t. iii, ff. 2–6; Faune Rhiz. Léman (1902), p. 242, ff. 1–4 (p. 243); and Sarc. grands Lacs (1905), p. 16, f. (p. 17); LEVANDER in Acta. Soc. Fauna Fenn. XX (1901), 8, p. 12, f. (p. 13); AVERINTZEV in Trudui

S.-Peterb. Obshch. XXXVI (1906), 2, p. 192; SCHOUTEDEN in Ann. Biol. Lacustre, I, 3 (1906), pp. 342, 346; SCHNEIDER in Arch. Biontol. II, 1 (1908), p. 58.

Test chitinous and transparent, elongated, tubular, straight, not compressed, in some examples perceptibly narrowed at the oral extremity; covered with variously-sized angular, siliceous scales, a ring of smaller ones surrounding the mouth, which either corresponds with the diameter of the test or is slightly dilated. The crown invariably surmounted by a tubular horn, which is more or less curved and deflected at a considerable angle, giving the test, at that part, an unsymmetrical outline. The horn formed of the same chitinous material as the test (in fact, a prolongation of it), and sometimes perforated at the apex. The organism not completely filling the interior of the test; one or two attachment-threads being visible in the posterior part. Pseudopodia simple and few in number; the nucleus spherical, and, under a high magnification, separated from the plasma, which has numerous round nucleoli embedded in its greyish substance, and one or two contractile vacuoles.

Dimensions: Length 150 μ (170 to 200 μ according to Penard) without the posterior horn.

In *Sphagnum*-bogs near Criccieth and in the Sychnant Pass, North Wales. In Loch Ness, Scotland, at a depth of 300 to 400 feet (*D. J. Scourfield*).

This species is rare in Britain. On the Continent, and mainly in the Swiss lakes, according to Penard, it occurs sporadically; in this country we have met with it very sparingly in wet *Sphagnum*. The peculiar horn is practically the only feature which differentiates it from ordinary *D. acuminata*. The form occurring in *Sphagnum* most nearly resembles one of Penard's figures in 'Faune Rhiz. Léman'; it differs from that figured in 'Les Sarc. des grands Lacs' in being narrowed below (considerably narrower at the mouth than posteriorly), and from the figure in Penard's earlier work in having the mouth not in the least dilated. The horn occupies an eccentric position; it makes the crown appear unsymmetrical; and as well as being inclined at an angle it is slightly incurved.

Apart from the transparent siliceous scales little extraneous matter is found adhering to the test of *D. curvicaulis*. The individuals occurring in *Sphagnum* seem to be less transparent than those inhabiting deep water, for which, as well as other peculiarities, the difference of habitat may sufficiently account.

11. **Difflugia lanceolata** Penard.

(Plate XIX, figs. 9–11.)

Difflugia pyriformis LEIDY (pars) Freshw. Rhiz. N. Amer. (1879), p. 98, t. x, f. 17.

Difflugia lanceolata PENARD in Mém. Soc. Genève, XXXI (1890), 2, p. 145, t. iv, ff. 59, 60; in Arch. Sci. nat. (3) XXVI (1891), p. 143; and Faune Rhiz. Léman (1902), p. 250, ff. 1–5 (p. 251); AVERINTZEV in Trudui S.-Peterb. Obshch. XXXVI (1906) 2, p. 205; SCHOUTEDEN in Ann. Biol. Lacustre, I, 3 (1906), pp. 343, 347.

Test thin, chitinous, transparent, with a covering of siliceous angular scales, and sometimes, but sparingly, minute sand-grains. Varying, within certain narrow limits, in size and form; ordinarily lanceolate from a bluntly-acuminate or convex crown, swelling rapidly to the greatest diameter, thence tapering convexly down to the narrow truncated mouth; the body of the animal usually occupying about two-thirds of the test, and attached to it by threads of ectoplasm. Pseudopodia few and simple, not branched; nucleus spherical.

Dimensions: Length 140–160 μ.

Ponds at Northenden, and elsewhere in Cheshire. Loch Ness, Scotland (*D. J. Scourfield*).

The test of this species is graceful in outline, and may readily be distinguished from that of *D. oblonga* var. *lacustris* by the uniformly-convex sides and the narrow mouth, not less than by the absence of large sand-grains. The chief variability consists in the sometimes rounded, sometimes bluntly-conical crown. The siliceous scales covering the test are glistening and transparent. From *D. oblonga* var. *venusta* the species is likewise easily differentiated, the lower part of the test being, as the figures show, destitute of a neck, though the two organisms exist side by side in the same ponds, and not infrequently in the same drop of water.

12. **Difflugia lucida** Penard.

(Plate XXI, figs. 3 and 4.)

Difflugia lucida Penard in Mém. Soc. Genève, XXXI (1890), 2, p. 145, t. iv, ff. 52–58; Faune Rhiz. Léman (1902), p. 273, ff. 1–5 (p. 274); in Jahrb. nassau. Ver. Naturk. XLIII (1890), p. 70; and in Arch. Protist. II (1903), p. 256; Averintzev in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 187; Schrouteden in Ann. Biol. Lacustre, I, 3 (1906), pp. 342, 345.

Test thin, chitinous, transparent, covered with variously-sized, angular, siliceous scales, very transparent, a ring of these scales generally surrounding the mouth; much compressed, the width in narrow lateral view hardly exceeding a third of the broader surface; in broad view uniformly arched, the sides straight, and sometimes nearly parallel from each cusp of the crown down to the truncated mouth. The body of the animal, which is visible through the transparent walls of the test, not occupying the whole of the cavity, being attached to the fundus by threads of protoplasm; nucleus normally situated; pseudopodia few in number, short, and simple.

Dimensions: Length 60–80 μ; breadth about 50 μ; in lateral view, breadth 17–20 μ.

In *Sphagnum*. Near Sutton Broad, Norfolk (*E. Gurney*). Towyn, Merionethshire. Midlothian, Scotland (*W. Evans*).

The test of this species differs from those of other *Difflugiæ* in being evenly compressed, so much so that the two sides, when the test is viewed laterally, are nearly parallel from the crown to the oral aperture. In broad view individuals differ in the degree of contraction anteriorly ; in British examples they are narrower, in proportion to the diameter below the crown, than Penard represents in his figures of continental examples, though in other respects no disparity is noticeable. The test when empty is bluish grey in colour, shining, transparent, and with no adventitious matter adhering except filmy siliceous particles.

13. **Difflugia globulus** (Ehrenberg).*

(Plate XXI, figs. 5-9 ; and figs. 52–54 and 110 in text.)

Arcella globulus EHRENBERG in Monatsb. Akad. Wiss. Berlin, 1848, p. 379 ; *op. cit.* 1856, p. 337, t., f. 4 (; ? *idem*, Mikrogeol. (1854), t. xxxiv, f. ii, 2 ; t. xxxviii, f. xxi, 9).

Difflugia proteiformis sub-sp. *globularis* WALLICH in Ann. Nat. Hist. (3) XIII (1864), p. 241, t. xv, f. 4 *h* ; t. xvi, ff. 1, 2, 17, 21.

Difflugia globularis LEIDY in Pr. Acad. Philad. 1877 (1878), pp. 307, 321. (Non *D. globularis* EHRENBERG in Abh. Akad. Wiss. Berlin, 1871 (1872), p. 253, t. iii, f. 24.)

Difflugia globulosa (Duj.) LEIDY (pars) Freshw. Rhiz. N. Amer. (1879), p. 96, t. xv, ff. 29, 30 ? ; t. xvi, ff. 1–10, 21–24 ; BÜTSCHLI in Bronn's Thier-Reichs, I, 1 (1880), t. iii, f. 1 ; HITCHCOCK Synops. Freshw. Rhiz. (1881), p. 11 ; TARÁNEK in Sitzber. böhm. Ges. Wiss. 1881 (1882), p. 226 ; DE TARR in Rep. N. York State Mus. XXXV (1884), p. 165 ; JICKELI in Zool. Anzeig. VII (1884), p. 449 ; in Ann. Nat. Hist. (5) XIV (1884), p. 297 ; and in Jrn. R. Micr. Soc. (2) IV (1884), p. 911 ; BLANC in Bull. Soc. Vaudoise (2) XX (1885), p. 288 ; in Ann. Nat. Hist. (5) XV (1885), p. 427 ; in Arch. Sci. nat. (3) XXVI (1891), p. 577 ; *op. cit.* (3) XXVII (1892), p. 472 ; and Difflugies Lac Léman (1892), p. 3, t. ii, ff. 7–10, 16–20 ; BLOCHMANN Mikr. Thierw. Süsswass. (1886), p. 12, t. i, f. 18 ; ed. 2 (1895), p. 16, t. i, f. 15 ; FIELDE in Pr. Acad. Philad. 1887, p. 122 ; FOREL in Boll. Scient. III, an. 9 (1887), p. 90 ;

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* [*Difflugia globularis* Wallich : CASH, MS.]

and Le Léman, III (1904), p. 138; Imhof in Jahresb. nat. Ges. Graubünd. (n.f.) XXX (1887), p. 65 etc.; and in Arch. Sci. nat. (3) XXV, p. 650; Whitelegge in Pr. Linn. Soc. N. S. Wales (2) I (1887), p. 500; and in Jrn. R. Soc. N. S. Wales, XXIII, 2 (1889), p. 287; Greeff in Sitzber. Ges. Nat. Marburg, 1888, 3, p. 107; Harvey in Amer. Nat. XXII (1888), p. 72; Moniez in Rev. Biol. nord France, I, 3 (1888), p. 86; Certes Prot. in Mission scient. Cap. Horn, VI (1889), 3, p. 13; Penard in Jahrb. nassau. Ver. Naturk. XLII (1889), p. 144; *op. cit.* XLIII (1890), p. 270; in Mém. Soc. Genève, XXXI (1890), 2, p. 142, t. iv, ff. 20, 21, 24–29; in Arch. Sci. nat. (3) XXVI (1891), p. 143; *op. cit.* (4) VII (1899), p. 261; Faune Rhiz. Léman (1902), p. 256, ff. 4–6 (p. 258); in Arch. Protist. II (1903), p. 256; and in Rev. Suisse Zool. XVI, 3 (1908), p. 462; Sacchi in Boll. Scient. III, an. 11 (1889), p. 68; and in Jrn. Microg. XIV (1890), p. 109; Daday in Termész. Füzetek, XIV (1891), p. 109; *op. cit.* XV (1892), p. 9 etc.; XX (1897), pp. 151, 175; and XXI, Suppl. 1898, pp. 6, 9; Lord in Sci. Goss. XXVII (1891), p. 133, ff. 96–99; and in Tr. Manch. Micr. Soc. 1891 (1892), p. 55; Cash in Tr. Manch. Micr. Soc. 1891 (1892), p. 49; Longhi in Atti Soc. Ligust. III (1892), p. 145; Maggi in Boll. Scient. IV, an. 15 (1893), p. 15; Schewiakoff in Mém. Acad. Sci. St. Pétersb. (7) XLI (1893), 8, p. 88; Levander in Acta Soc. Fauna Fenn. XII (1894), 2, p. 17; *op. cit.* XVIII (1900), 6, p. 50; XX (1901), 8, p. 7 etc.; and in Zool. Anzeig. XVII (1894), p. 209; Rhumbler in Zeits. wiss. Zool. LXI, 1 (1895), p. 74 etc., t. iv, f. 21; Zschokke in Verh. nat. Ges. Basel, XI (1895), 1, p. 57; Entz in Res. wiss. Erforsch. Balatons. II (1897), 1, p. xxiv; Francé in Res. wiss. Erforsch. Balatons. II (1897), 1, p. 8; Frenzel Prot. in Bibl. Zool. IV, 12 (1897), p. 135, t. ix, ff. 8, 9; Fuhrmann in Rev. Suisse Zool. IV (1897), p. 498 etc.; Schaudinn in Deutsch-Ost-Africa, IV, 2 (1897), 19, p. 8; Scourfield in Pr. Zool. Soc. 1897, p. 787; Zacharias in Forschb. zool. Stat. Plön, V (1897), p. 113; André in Jahresb. nat. Ges. Graubünd. (n.f.) XLI (1898), p. 57 etc.; Hempel in Bull. Illinois State Lab. V (1898), p. 318; Stenroos in Acta Soc. Fauna Fenn. XVII (1898), 1, p. 34 etc.; Averintzev in Trudui S.-Peterb. Obshch. XXX, 1 (1900), p. 239; *op. cit.* XXXVI (1906), 2, p. 201; in Ber. Süsswass. nat. Ges. St. Petersb. I (1901), p. 211; in Protok. S.-Peterb. Obshch. XXXI (1901), p. 323; and in Zool. Anzeig. XXXI (1907), p. 348; Calkins Protozoa (1901), p. 97; Lager-

HEIM in Förh. Geol. Fören. Stockholm, XXIII (1901), p. 511 etc.; G. S. WEST in Jrn. Linn. Soc., Zool. XXVIII (1901), p. 324; and in Ann. Scott. Nat. Hist. 1906, pp. 90, 92; BEARDSLEY in Tr. Amer. Micr. Soc. XXIII (1902), p. 57; KOFOID in Bull. Illinois State Lab. VI, 1 (1903), p. 516; ZYKOFF in Bull. Soc. Nat. Moscou, XVII (1903), 1, pp. 15, 107; MURRAY in Pr. R. Soc. Edinb. XXV, 8 (1905), p. 614; and in Ann. Scott. Nat. Hist. 1907, p. 94; CUSHMANN in Amer. Natur. XL (1906), p. 372; SCHORLER & THALLWITZ in Ann. Biol. Lacustre, I, 2 (1906), p. 270 etc.; SCHOUTEDEN in Ann. Biol. Lacustre, I, 3 (1906), pp. 343, 347; THIEBAUD & FAVRE in Ann. Biol. Lacustre, I, 1 (1906), p. 76 etc.; and in Zool. Anzeig. XXX (1906), p. 156; LEMMERMANN in Arch. Hydrobiol. II, 4 (1907), p. 537; SCHNEIDER in Arch. Biontol. II (1908), 1, p. 58.

Difflugia globosa GOLDSMIDT in Arch. Protist. V, 1 (1904), p. 131.

Test ordinarily globular or hemispherical, but subject to variation, truncated on the broad ventral surface; composed of chitinous membrane, with an incrustation of sand-grains or diatom-frustules, or both of these; the mouth circular, its margins not invaginated, often large proportionately to the size of the structure. Protoplasm colourless, containing chlorophyllous food-particles and a single nucleus; pseudopodia single, blunt, few in number.

Dimensions: 15–50 μ or more in longest diameter.

In the ooze of ponds; in marshes and amongst *Sphagnum* and other mosses in moist places; common.

A good deal of confusion has arisen with regard to this species. The name *globulosa* was given by Dujardin (1837) to a testaceous rhizopod palpably different from that to which, since his time, it has been applied by authors. Dujardin's figure represents a smooth-surfaced apparently chitinoid test, semi-opaque, ovoid in lateral, and elliptic in dorsal view, with the mouth—a very small, circular orifice—situated at the narrow extremity, with the blunt, digitate, and sometimes branched bifurcate pseudopodia issuing from it. We are unable to correlate Dujardin's figures with any known species of *Difflugia*. The *D. globulosa* of modern authors is well known as having a globose or hemispherical test, with an oral aperture —comparatively large—situated not at the extremity of an ovoid body, but on the basal surface (in this case the ventral surface) of the hemisphere—a quite different arrangement. But if we cannot accept *D. globulosa* Duj. on account of its ambiguity, still less is it permissible to perpetuate a name which the author clearly never designed for the organism which now bears it.

A way out of the difficulty is suggested by a reference to Dr. Wallich's paper on "Structural Variation among the Difflugian Rhizopods," in the 'Annals and Magazine of Natural History' for 1864. The species we have hitherto known as *D. globulosa* Duj. is there referred to, and figured, as "*Difflugia globularis* Duj."—obviously an error, which the writer has repeated throughout his paper. There was no "*D. globularis*" known when Wallich, apparently unconscious of his error, invented the name and credited it to Dujardin.

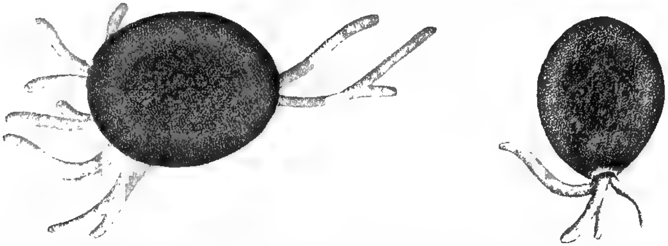
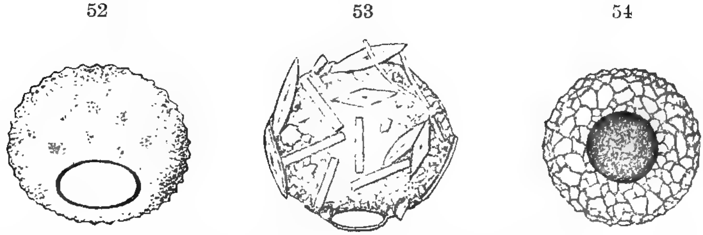


FIG. 51.—*Difflugia globulosa* Dujardin : ? = *D. lobostoma*. After Dujardin, in Ann. Sci. Nat., 2, VII (1837), t. ix, ff. 1 *a*, 1 *b*. × about 200.

[It is not however necessary to take advantage of Wallich's error, for the species was described, though not very fully, by Ehrenberg in 1848 and figured by him in 1856. His description is: "*Arcella ? globulus*, lorica subglobosa laxe venosa-reticulata, venulis granulatis, apertura ampla simplici. Diameter $\frac{1}{48}'''$." The reticular venation is not shown in his figure, which certainly represents a sand-covered species which can only be that under consideration. It is probable that in 1856 he figured a different example from the one he described in 1848. Those which appear in his 'Mikrogeologie' (1854) under the same name are neither sand-covered nor veined, and may not be the same species, most probably being *Centropyxis ecornis*, a view apparently held by Leidy. (See 'Freshw. Rhiz. N. Amer.,' p. 305.) It may be noted that Wallich describes one of his figures (f. 17) as of the "typical form, but made up of large sandy particles," as if that were the exception rather than the rule. He also figures one (f. 21) "chiefly made up of minute diatoms."]



FIGS. 52-54.—*Difflugia globulus*: 52, after Ehrenberg, *loc. cit.* 1856 (enlarged); 53, from Cocket Moss, W. Yorks, drawn by G. S. West (reduced); 54, after Wallich, *loc. cit.* f. 2 a (enlarged). Variously magnified.

Leidy joins several forms, now recognized as distinct, under the name of "*D. globulosa* Duj."—connecting it with "*D. pyriformis* Perty" (*D. oblonga* Ehrenb.) on the one hand, and with *D. lobostoma* Leidy, on the other. A new genus, *Phryganella*, was established by Penard ('Mém. Soc. Phys. Genève,' XXXI, 1890) to receive forms differing from *D. globulus* mainly in the character of their pseudopodia. Empty tests varying in size and structure are met with in *Sphagnum*, of which it cannot be said positively that they belong to *Difflugia globulus* Ehrenb., to *Phryganella acropodia* (Hertw. & Less.), or to *Pseudodifflugia gracilis* Schlumb. One of the forms figured by Leidy under "*D. globulosa* Duj." is *Centropyxis arcelloides* Penard.

14. **Difflugia brevicolla** *sp. nov.*

(Plate XIX, figs. 12 and 13; and fig. 55 in text.)

Test spherical, with a short neck, the extremity of which is truncated to form the circular mouth, its margin plain, without contraction or dilatation; structure chitinoid, with a surfacing of irregular scales or these with an admixture of small diatom-frustules, and occasionally a few sand-grains; sometimes with a single quartz particle of larger size adhering to the crown. Characters of the plasma, pseudopodia, and nucleus unknown.

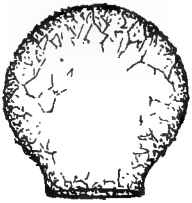


FIG. 55.—*Difflugia brevicolla.* Empty test from Dunham Marsh. × 280.

Dimensions: Diameter 70–90 μ; of mouth 35–40 μ.

In deep ditches of peat-bogs and open ponds amongst decaying vegetation. Risley Moss, Lancashire, 1903; Chilford and Dunham, Cheshire.

In peat-bogs the test of this species is found to take on the brownish colour of the water, its opacity increasing with age. In ponds, on the contrary, it does not differ in colour from other *Difflugiæ* of similar structure. No example was found in the active state, but amongst the numerous examples from the first-named locality two were observed in conjugation.

15. **Difflugia orbicularis** *sp. nov.*

(Plate XX, figs. 6 and 7.)

Test minute, spherical, with a short neck, chitinoid, yellowish, or lightish brown, destitute of incrustation;

the neck truncated by the narrow circular mouth. Protoplasm colourless, containing one or more clear vesicles, with minute chlorophyl-pallets throughout its substance, and a single nucleus near the crown; the pseudopodia slender, simple, three or four.

Dimensions: Diameter 75–90 μ; length of neck about 10 μ; diameter of mouth about 20 μ.

In bog-pools at Dunham, Cheshire, 1891.

This pretty rhizopod, though minute and possessing a naked chitinous test, must (at least provisionally) find a place among the *Difflugiæ*. Differing so much in appearance from other members of the genus, it may seem out of place, but it would be more so in any of the genera which have purely chitinous tests. It may be readily distinguished by the spherical, yellowish, homogeneous test, and the short neck, with its narrow oral aperture. The organism was discovered in tufts of wet moss, in the living state, together with numerous empty tests, in a bog at Dunham, but it has not been since met with there or elsewhere.

16. **Difflugia urceolata** Carter.

(Plate XXI, figs. 10–12; and fig. 57 in text.)

Difflugia urceolata CARTER in Ann. Nat. Hist. (3) XIII (1864), pp. 27, 37, t. i, f. 7; PARFITT in Tr. Devon Assoc. III (1869), p. 66; LEIDY (pars) in Pr. Acad. Philad. 1877 (1878), p. 307; and Freshw. Rhiz. N. Amer. (1879), p. 106, t. xiv, ff. 1, 2, 5–7; xix, ff. 28, 29; BÜTSCHLI in Bronn's Thier-Reichs, I, 1 (1880), t. iii, f. 8; HITCHCOCK Synops. Freshw. Rhiz. (1881), p. 13; VEJDOVSKÝ in Sitzber. böhm. Ges. Wiss. 1880 (1881), p. 138; TARÁNEK in Sitzber. böhm. Ges. Wiss. 1881 (1882), p. 227; DE TARR in Rep. N. York State Mus. XXXV (1884), p. 166; BLANC in Bull. Soc. Vaudois (2), XX (1885), p. 288; in Ann. Nat. Hist. (5) XV (1885), p. 427; in Arch. Sci. nat. (3) XXVI (1891), p. 576; and Difflugies Lac Léman (1892), p. 2, t. ii, ff. 1–5, 21, 22; DADAY in Értez. math. termész. Akad. Budapest, III (1885), p. 161; in Termész. Füzetek, XIV (1891), p. 110; *op. cit.* XV (1892), pp. 9, 175, etc.; XX (1897), p. 163 etc.; and XXI (1898), pp. 6, 9; Forel Faune Lacs Suisse (1885), p. 131; and in Boll. Scient. III, an. 9 (1887), p. 90; Blochmann Mikr. Thierw. Süsswass. (1886), p. 12, t. i, f. 20; ed. 2 (1895), p. 16, t. i, f. 17; Bolton in Midl. Natur. IX (1886), p. 174; Fielde in Pr. Acad. Philad. 1887, p. 31; Whitelegge in Pr. Linn. Soc. N. S. Wales (2) I (1887), p. 500; and in Jrn. R. Soc. N. S. Wales, XXIII, 2 (1889), p. 297; Verworn in Zeits. wiss. Zool. XLVI, 4 (1888), p. 455, t. xxxii, ff. 1–6, and ff. *a–f* (p. 460); in Ann. Nat. Hist. (6) II (1888), p. 156; in Jrn. R. Micr. Soc. 1888, p. 755; and Psycho-phys. Prot.-stud. (1889), p. 76, f. 9; Certes in Mission scient. Cap. Horn, VI (1889), 3, Prot., p. 13; Sacchi in Boll. Scient. III, an. 11 (1889), p. 68; and in Jrn. Microg. XIV (1890), p. 109; Gruber in Zacharias' Tierw. Süsswass. (1891), II, p. 139, f. 16 (1); Lord in Sci. Goss. XXVII (1891), p. 233, f. 104; and in Tr. Manch. Micr. Soc. 1891 (1892), p. 55; Penard in Arch. Sci. nat. (3) XXVI (1891), p. 143; and Faune Rhiz. Léman (1902), p. 266, ff. 1–7 (p. 267); Rhumbler in Zeits. wiss. Zool. LII, 4 (1891), p. 517 etc.; and *op. cit.* LXI, 1 (1895), p. 95; Schewiakoff in Mém. Acad. Sci. St. Pétersb. (7) XLI (1893), 8, p. 98; Barrois in Rev. biol. nord France, VI (1894), p. 284; Levander in Acta Soc. Fauna Fenn. XII (1894), 2, p. 17; *op. cit.* XIX (1900), 2, pp. 7, 13; and XX (1901), 8, p. 8 etc.; Francé in Res. wiss. Erforsch. Balatons. II (1897), 1, p. 7; Fuhrmann in Rev. Suisse Zool. IV (1897), p. 491 etc.; Zacharias in Forschb. zool. Stat. Plön, V (1897), p. 113; Hempel in Bull. Illinois State Lab. V (1898), p. 319; Stenroos in Acta Soc. Fauna Fenn. XVII (1898), 1, p. 33 etc.; Eyferth Naturgesch. mikr. Süsswass. (1900), p. 262; Godet in Bull. Soc. Neuchâtel, XXVIII (1900), p. 77; Averintzev in Ber. Süsswass. nat. Ges. St. Petersb. I (1901), p. 212; in Trudui S.-Peterb. Obshch. XXX, 1 (1900), p. 239; and *op. cit.* XXXVI (1906), 2, p. 212; G. S. West in Jrn. Linn. Soc., Zool. XXVIII (1901), p. 318; Zykoff in Bull. Soc. Nat. Moscou, XVII (1903), 1, pp. 15, 107; and in Zool. Anzeig. XXIX (1906), pp. 279, 478; Forel Le Léman, III (1904), p. 138; Zuelzer in Arch. Protist. IV, 2 (1904), p. 240, tt. x–xii, and text-ff. 1, 2; Murray in Pr. R. Soc. Edinb. XXV, 8 (1905), p. 609; Edmonston in Pr. Davenport Acad. Sci. XI (1906), p. 15, t. iii, f. 19; Schorler & Thallwitz in Ann. Biol. Lacustre, I, 2 (1906), pp. 260, 286; Schouteden in Ann. Biol. Lacustre, I, 3

(1906), pp. 344, 348; THIEBAUD in Zool. Anzeig. XXX (1906), p. 156; THIEBAUD & FAVRE in Ann. Biol. Lacustre, I, 1 (1906), p. 76 etc.; HOOGENRAAD in Tÿdschr. Nederl. Dierk. Ver. (2) X (1908), p. 407; LANDACRE in Pr. Davenport Acad. Sci. IV, 10 (1908), p. 428.

Difflugia proteiformis sub-sp. *mitriformis* var. *lageniformis* WALLICH in Ann. Nat. Hist. (3) XIII (1864), p. 240, t. xvi, ff. 15, 16.

Difflugia lageniformis BÜTSCHLI in Bronn's Thier-Reichs, I, 1 (1880), t. iii, f. 8.

Test ovoid, rotund, its crown obtusely and evenly rounded, plain, or furnished with one or more short bluntly-conical protuberances; the neck short, constricted above the wide circular mouth, which has an expanded and slightly-recurved rim, its basal outline being straight or convex. Body of the test, as well as the expanded mouth, incrusted with quartzose sand-grains and other opaque material. The plasma plurinuclear, colourless; the pseudopodia digitate, simple or branching, generally numerous.

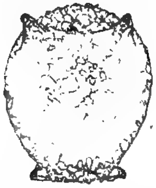


FIG. 56.—Typical form of *Difflugia urceolata*. From Richmond Park, Surrey. × about 180.

Dimensions: Length 220–230 μ; breadth 150–200 μ.

In ponds and ditches, not common. Richmond Park, Surrey. Chipperfield, Herts (*A. Earland*). Bowness, Westmoreland (*G. S. West*). Loch Ness, Scotland (*D. J. Scourfield*).

D. urceolata is one of the largest of our native *Difflugiæ*. Though widely distributed in Europe and America, it is not abundant in England. Both the spined and spineless forms, however, occur in different parts of this country. The test is opaque, and without its destruction the protoplasmic body cannot be examined. It was on this species that Verworn (1888) experimented in order to determine whether a difflugian rhizopod had the power of reconstructing or repairing its damaged test. He found that regeneration of the injured or completely-removed test, by the protoplasmic body, does not occur, although the vital functions take their course in normal fashion.* The same observer demonstrated that the structure of the test is completed, when fission takes place, at the moment of separation of the new individual. No subsequent alterations occur and no after-growth takes place.

FIG. 57.—*Difflugia urceolata* with plain crown. Bowness, Westmoreland. From a drawing by G. S. West. × 310.

These conclusions corroborate Gruber's, on the same point, arrived at from independent observations.

The species seems quite indifferent to climate or altitude. In America Leidy found it flourishing abundantly in swampy pools in New Jersey and equally so at an elevation of 10,000 feet in Wyoming Territory. Examples varied in the crown being plain, or furnished with spines—conical, acuminate, or acute. The spined form—apparently identical with our own—occurred in sphagnous pools, together with a variety (var. *olla*) distinguished by the peculiarity of having its spines mostly blunt and tipped with a single stone flake of greater width than the spine at its point of attachment.

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* 'Zeitschr. für wiss. Zool.,' Bd. xlvi, pp. 455–461.

17. **Difflugia amphoralis** *sp. nov.**

(Plate XXI, fig. 13.)

Difflugia amphora Leidy (pars) in Pr. Acad. Philad. 1874, p. 79; Lagerheim? in Förh. Geol. Fören. Stockholm, XXIII (1891), p. 509; Averintzev (pars) in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 184; Schouteden in Ann. Biol. Lacustre, I, 3 (1906), pp. 341, 345, f. 15; Schneider? in Arch. Biontol. II, 1 (1908), p. 58.

Difflugia urceolata Leidy (pars) Freshw. Rhiz. N. Amer. (1879), p. 106, t. xiv, f. 8?; t. xvi, f. 33.

Difflugia urceolata var. *amphora* Leidy (pars), Freshw. Rhiz. N. Amer. (1879), t. xvi, f. 34.

(Non *Difflugia amphora* Ehrenberg in Abh. Akad. Wiss. Berlin, 1871 (1872), p. 248.)

Smaller than *Difflugia urceolata*, and differing from it in having the crown neither convex nor spined, but pointed like a Gothic arch; the mouth with an expanded but not upturned rim below the constricted neck. The test composed of chitinous material, surfaced with amorphous (? siliceous) scales, but few sand-grains; semitransparent. The plasma-body not connected with the sides but attached to the fundus by threads of ectoplasm. Nucleus single; pseudopodia numerous, simple or digitate.

Dimensions: Length about 115 μ; greatest width 70 μ; width at constriction of neck 40 μ.

In marshy places amongst *Sphagnum*, near Criccieth, Carnarvonshire, August, 1904.

Difflugia amphoralis is distinct from *D. amphora* Penard. In the latter (not observed in Britain) the mouth has a peculiar chitinous rim with a wavy and sharply-cut outline.

[Differing from *Difflugia urceolata* in having only a single nucleus, as well as in the nature of the test and the form of its crown and aperture, *D. amphoralis* seems to be clearly entitled to specific rank. It cannot be called *Difflugia amphora*, that name having been used by Ehrenberg in 1871. In mentioning only Penard's *D. amphora*, which is not a variety of *D. urceolata*, but a distinct and well-marked species, Mr. Cash has apparently overlooked at least one form of Leidy's variety of that name with which *D. amphoralis* appears to be identical.]

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* [*Difflugia urceolata* var. *amphora* var. nov.: Cash, MS.]

18. **Difflugia lobostoma** Leidy.*

(Plate XXI, figs. 14–17; and figs. 58, 59, and 61 in text.)

Difflugia tricuspis Carter? in Ann. Nat. Hist. (2) XVIII (1856), pp. 221, 247, t. vii, f. 80; Ehrenberg in Abh. Akad. wiss. Berlin, 1871 (1872), p. 264.

Difflugia oblonga Fresenius in Abth. Senkenb. nat. Ges. II (1857), p. 225, t. xii, ff. 43–45; Eyferth Naturgesch. mikr. Süsswass. ed. 2 (1885), p. 51, t. iii, f. 34.

Difflugia lobostoma Leidy (pars) in Pr. Acad. Philad. 1874, p. 79; *op. cit.* 1877 (1878), p. 307; 1881, p. 10; and Freshw. Rhiz. N. Amer. (1879), p. 112, t. xv, ff. 1–14, 20–24; t. xvi, ff. 25–29; Hitchcock Synops. Freshw. Rhiz. (1881), p. 14; Taránek in Sitzber. böhm. Ges. Wiss. 1881 (1882), p. 227; De Tarr in Rep. N. York State Mus. XXXV (1884), p. 166; Fielde in Pr. Acad. Philad. 1887, p. 122; Certes Prot. in Mission Scient. Cap. Horn, VI (1889), 3, 13; Penard in Jahrb. nassau. Ver. Naturk. XLIII (1890), p. 70; in Mém. Soc. Genève, XXXI (1890), 2, p. 147, t. iv, ff. 72–90, 96; in Arch. Sci. nat. (4) VII (1899), p. 253 etc.; in Rev. Suisse Zool. VIII, 3 (1900), p. 485; and Faune Rhiz. Léman (1902), p. 276, ff. 1–7 (p. 277); Verworn in Zeits. wiss. Zool. L, 2 (1890), p. 444, t. xviii, and text-ff. *a–c*; Rhumbler in Zeits. wiss. Zool. LII, 4 (1891), p. 547; *op. cit.* LXI, 1 (1895), p. 44; and in Biol. Centralbl. XVIII (1898), p. 36, f. 2; Cash in Tr. Manch. Micr. Soc. 1891 (1892), p. 48; Levander in Arch. Ver. Mecklenb. XLVII (1892), p. 114; in Acta Soc. Fauna Fenn. XII (1894), 2, p. 16, t. i, ff. 10–13; *op. cit.* XIX (1900), 2, p. 52; XX (1901), 5, p. 11 etc.; 6, p. 5; 8, p. 8 etc.; and in Zool. Anzeig. XVII (1894), p. 209;

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* [*Difflugia tricuspis* Carter: Cash, MS.]

Moore in Ann. Nat. Hist. (6) XI (1893), p. 48; Schewiakoff in Mém. Acad. Sci. St. Pétersb. (7) XLI (1893), 8, p. 98; Daday in Termész. Füzetek. XX (1897), p. 156; and *op. cit.* XXI (1898), Suppl. pp. 6, 9; Entz in Res. wiss. Erforsch. Balatons. II (1897), 1, p. xxiv; Fuhrmann in Rev. Suisse Zool. IV (1897), p. 510 etc.; Schaudinn in Deutsch-Ost-Africa, IV, 2 (1897), 19, p. 9; Zacharias in Forschb. zool. Stat. Plön, V (1897), p. 113; Fick in Zool. Centralbl. V (1898), p. 324; Hempel in Bull. Illinois State Lab. V (1898), p. 319; Stenroos in Acta. Soc. Fauna Fenn. XVII (1898), 1, p. 34 etc.; Averintzev in Trudui S.-Peterb. Obshch. XXX, 1 (1900), p. 239; *op. cit.* XXXI, 1 (1901), p. 212; XXXVI (1906), 2, p. 186; and in Ber. Süsswass. Nat. Ges. St. Petersb. I (1901), p. 212; Eyferth Naturgesch. mikr. Süsswass. ed. 3 (1900), p. 263, t. ix, f. 13; Godet in Bull. Soc. Neuchâtel, XXVIII (1900), p. 77; Prowazek in Arb. zool. Inst. Wien, XII (1900), p. 253; Lagerheim in Förh. Geol. Fören. Stockholm, XXIII, 6 (1901), p. 511 etc.; Lang Lehrb. vergl. Anat., Prot. (1901), pp. 91, 270, ff. 102, 251; Sand Étude Infus. tentaculif. (1901), pp. 82, 134; G. S. West in Jrn. Linn. Soc., Zool. XXVIII (1901), p. 320; Beardsley in Tr. Amer. Micr. Soc. XXIII (1902), p. 57; Zykoff in Bull. Soc. Nat. Moscou, XXVII (1903), 1, p. 16, f. 7; Murray in Pr. R. Soc. Edinb. XXV, 8 (1905), p. 609; Cushmann in Amer. Natur. XL (1906), p. 372; Edmonston in Pr. Davenport Acad. Sci. XI (1906), p. 15, t. ii, f. 10; Schorler & Thallwitz in Ann. Biol. Lacustre, I, 2 (1906), pp. 260, 286; Schouteden in Ann. Biol. Lacustre, I, 3 (1906), pp. 341, 345, f. 20; Le Roux in Ann. Biol. Lacustre, II, 3 (1907), p. 368; Skorikov in Bull. Acad. Sci. St. Pétersb. (6) I (1907), p. 120 etc.; Landacre in Tr. Ohio Acad. Sci. IV, 10 (1908), p. 428; Schneider in Arch. Biontol. II, 1 (1908), p. 58.

Difflugia crenulata Leidy in Pr. Acad. Philad. 1874, p. 79.

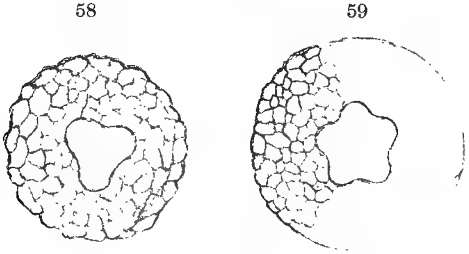
Difflugia lobostomata Hempel in Bull. Illinois State Lab. V (1898), p. 319; Calkins Prot. (1901), f. 118 a–c.

Test variable in form—sub-spherical to ovoid—composed of fine sand-grains or muddy particles, smooth-surfaced, opaque, without neck; the mouth 3–6 lobed, the lobes with rounded sinuses, and of regular formation, without any accompaniment of larger quartz-grains. Protoplasm colourless, except for the presence of chlorophyllous food-particles ; the pseudopodia simple, digitate.

Dimensions : Length 90–115 μ; breadth 80–95 μ.

In ponds, ditches, and marshy places, not infrequent. Chipperfield, Herts (*A. Earland*). North and West Yorkshire ; also Llyn Cwlyd and Capel Curig, North Wales (*G. S. West*). Loch Ness, Scotland (*J. Murray*).

Leidy, in his description of this species, included every form which had a three- to six-lobed mouth, without paying much regard to structure—that is to say, whether the lobes were regular or irregular, rounded or angular. There seems every justification, from more recent investigations, for separating some of the forms.



FIGS. 58 AND 59.—Oral views of *Difflugia lobostoma* showing great variation in size: 58, from Carlton Banks, N. Yorks, × 520; 59, from Sedburgh, W. Yorks, × 100. From drawings by G. S. West.

D. gramen Penard, and others, differ from *D. lobostoma*, in having tests which are overlaid with coarse sand-grains, giving them a rough exterior, whilst *D. lobostoma* is comparatively smooth, its lobed mouth beautifully cut, and the entire structure more gracefully outlined. Leidy remarks that tests are sometimes met with of which the mouths are six-lobed.* Some examples gathered by us in Richmond Park presented this feature, and the fact of *D. corona* Wallich being found in the same locality may give colour to that author's surmise that *D. corona* and *D. lobostoma* merge into one another by intermediate stages. There is no conclusive evidence, however, that they do so. The sinuses in the three-lobed or four-lobed mouth of *D. lobostoma* are deeper and wider than those of the multi-lobed mouth of *D. corona*, not to mention other disparities in the tests of the two species.

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* [He figures one with seven lobes (' Freshw. Rhiz. N. Amer.,' t. xv, f. 14).]

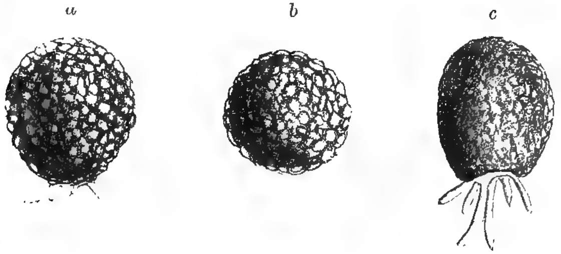
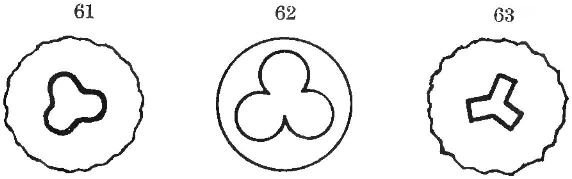


FIG. 60.—*Difflugia proteiformis* Ehrenb. Three aspects of the same individual. ? = *D. lobostoma*. After Ehrenberg, 'Infus.' t. ix. f. 1 *a–c* (reduced). × 200.

In our remarks on *D. oblonga* Ehrenb. reference is made to the uncertainty regarding the particular organism to which Ehrenberg applied the name *D. proteiformis*. There is more probability of the author having had before him examples of *D. lobostoma* —judging from his figures—than any other rhizopod.



FIGS. 61–63.—Diagrammatic oral views of the tests of (61) the 3-lobed form of *Difflugia lobostoma*, (62) *D.* "*tricuspis*" (after Carter), and (63) *D. gramen*.

Upon the confusion in nomenclature which has arisen Leidy observes (under *D. lobostoma*): "As ordinarily seen it [the test] bears so close a resemblance with the corresponding views of *D. proteiformis* as described and figured by Ehrenberg, that it may not only be readily taken for the same, but I have suspected that Ehrenberg may have actually had this animal under observation when he described *D. proteiformis*. Ehrenberg, however, makes no allusion to the characteristic mouth of the latter. . . . The name of *D. proteiformis* is exceedingly indefinite in its application. It was originally applied by Lamarck, without discrimination, to all the forms figured and described by Leclerc as characteristic of the genus *Difflugia*."

[Leidy, in proposing for this species the name *Difflugia lobostoma*, considered it to be the same as Carter's *D. tricuspis* from Bombay, but he rightly deemed that name to be inappropriate for a form having an aperture with a varying number of cusps or lobes. If, however, Carter's figures are correct, his species differs in general outline from that which we know as *lobostoma*, as well as in the form of the aperture and its size in relation to the diameter of the test, so that its reference to that species is very doubtful, and although the name *tricuspis* was adopted by Mr. Cash, it seems better to use the one by which the species has been universally known for the last thirty-five years. By Averintzev *D. tricuspis* is referred, with a query, to the next species.]

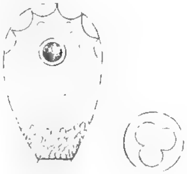


FIG. 64.—*Difflugia tricuspis* Carter. After Carter, *loc. cit.* × about 280.

19. **Difflugia gramen** Penard.

(Plate XXII, figs. 1 and 2; and fig. 64 in text.)

Difflugia tricuspis CARTER ? in Ann. Nat. Hist. (2) XVIII (1856), p. 247, t. vii, f. 80.

Difflugia lobostoma LEIDY (pars) Freshw. Rhiz. N. Amer. p. 112, t. xv, f. 15; ? ff. 23, 24.

Difflugia gramen PENARD Faune Rhiz. Léman (1902), p. 281, ff. 1–6 (p. 282); AVERINTZEV in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 186; SCHOUTEDEN in Ann. Biol. Lacustre, I, 3 (1906), pp. 341, 345.

Test resembling that of the preceding species but smaller, and differing from it also in the character of the mouth, which is 3-lobed, the lobes irregular and their extremities quadrangular; the whole external surface rough with sand-grains; in face view round, in side view roundly ovate, without neck. Nucleus single; pseudopodia normal.

Dimensions: Average length 70 μ; breadth 55–60 μ.

In the ooze of ponds. Frequent in Cheshire. Nant Francon, N. Wales (*J. Hopkinson*). Loch Ness, Scotland (*D. J. Scourfield*).

This species, which Leidy included under *D. lobostoma*, differs from what we have regarded as the typical form of that species in the contour of the mouth; the test also is much smaller, and is generally rough with adhering sand-grains. It is variable in size. Examples are sometimes met with which are semi-opaque, of a purplish-grey colour, and covered with irregular scales, or thin, apparently siliceous, particles, and few sand-grains. Some of these approach nearly to *D. limnetica* Levander in size, but we have not been able to discover anything like a neck in any examples that we have met with.

[Penard figures this species with curved as well as with rectangular lobes to the aperture, and Leidy figures a form, which appears to represent it, with a 5-lobed aperture (fig. 23, *loc. cit.*). It may be the case that the number of lobes varies in this species as well as in *D. lobostoma* and *D. corona*.]

20. **Difflugia corona** Wallich.

(Plate XXII, figs. 3–7; and fig. 65 in text.)

Difflugia proteiformis sub-sp. *globularis* var. *corona* WALLICH in Ann. Nat. Hist. (3) XIII (1864), p. 241.

Difflugia corona WALLICH in Ann. Nat. Hist. (3) XIII (1864), p. 244, t. xv, f. 4 *b, c*; t. xvi, ff. 19, 20; ARCHER (?) in Q. Jrn. Micr. Sci. (n.s.) VI (1866), pp. 186, 266; and in Jrn. Dublin Micr. Club, I, 2 (1867), pp. 51, 65; LEIDY (pars) in Pr. Acad. Philad. 1874, pp. 14, 79; *op. cit.* 1877 (1878), p. 307; and Freshw. Rhiz. N. Amer. (1879), p. 117, t. xvii, ff. 1–6, 11, 14; BÜTSCHLI in Bronn's Thier-Reichs, I, 1 (1880), t. iii, f. 5; HITCHCOCK Synops. Freshw. Rhiz. (1881), p. 15; TARÁNEK in Sitzber. böhm. Ges. Wiss. 1881 (1882), p. 228; DE TARR in Rep. N. York State Mus. XXXV (1884), p. 166; DADAY in Értesz. math. termész. Akad. Büdapest, III (1885), p. 161; BLOCHMANN Mikr. Thierw. Süsswass. (1886), p. 13, t. i, f. 23; ed. 2 (1895), p. 16; BOLTON in Midl. Natur. IX (1886), p. 174; FIELDE in Pr. Acad. Philad. 1887, p. 122; WHITELEGGE in Pr. Linn. Soc. N. S. Wales, (2) I (1887), pp. 498, 500; and in Jrn. R. Soc. N. S. Wales, XXIII, 2 (1889), p. 297; CERTES in Mission scient. Cap. Horn, VI, 3, Prot. (1889), p. 13; PENARD in Mém. Soc. Genève, XXXI (1890), 2, p. 141, t. iv, ff. 15–19; in Jahrb. nassau. Ver. Naturk. XLIII (1890), p. 70; and Faune Rhiz. Léman (1902), p. 287, ff. 1–6; ZACHARIAS in Biol. Centralbl. IX (1890), pp. 112, 113; Tierw. Süsswass. (1891), II, p. 311; in Forschb. biol. Stat. Plön, V (1897), p. 113; and *op. cit.* X (1903), p. 241; DADAY in Termész. Füzetek, XIV (1891), p. 109; *op. cit.* XV (1892), pp. 3, 168, etc.; XX (1897), pp. 153, 156; and XXI (1898), pp. 6, 9; FRANCÉ in Res. wiss. Erforsch. Balatons. II (1897), 1, p. 3; FUHRMANN in Rev. Suisse Zool. IV (1897), p. 491; SCHAUDINN in Deutsch-Ost-Africa, IV, 2 (1897), 19, p. 9; HEMPEL in Bull. Illinois State Lab. V (1898), p. 320; STENROOS in Acta Soc. Fauna Fenn. XVII (1898), 1, p. 35 etc.; EYFERTH Naturgesch. mikr. Süsswass. ed. 3 (1900), p. 263; LEVANDER in Acta Soc. Fauna Fenn. XIX (1900), 2, p. 22 etc.; and *op. cit.* XX (1901), 8, p. 8 etc.; LAGERHEIM in Förh. Geol. Fören. Stockholm, XXIII, 6 (1901), p. 471; G. S. WEST in Jrn. Linn. Soc., Zool. XXVIII (1901), p. 320; BEARDSLEY in Tr. Amer. Micr. Soc. XXIII (1902), p. 57; ZACHARIAS in Forschb. zool. Stat. Plön, X (1903), p. 241; CUSHMAN in Amer. Natur. XL (1906), p. 372; ZYKOFF in Zool. Anzeig. XXVII (1904), p. 214; EDMONSTON in Pr. Davenport Acad. Sci. XI (1906), p. 16, t. iii, f. 16; AVERINTZEV in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 215; and in Ann. Biol. Lacustre, II (1907), p. 164; SCHORLER & THALLWITZ in Ann. Biol. Lacustre, I, 2 (1906), p. 260;

SCHOUTEDEN in Ann. Biol. Lacustre, I, 3 (1906), pp. 344, 348, f. 21; ZSCHOKKE in Arch. Hydrobiol. II, 1 (1906), p. 3; LEMMERMANN in Arch. Hydrobiol. II, 4 (1907), p. 537; SKORIKOV in Bull. Acad. Sci. St. Pétersb. (6) I (1907), pp. 124, 125, etc.; HOOGENRAAD in Tÿdschr. Nederl. Dierk. Ver. (2) X, 4 (1908), p. 407; LANDACRE in Pr. Davonport Acad. Sci. IV, 10 (1908), p. 428.

Corona cornula VEJDOVSKÝ in Sitzber. böhm. Ges. Wiss. 1880 (1881), p. 137.

Difflugia acuminata var. *furcata* DADAY in Termész. Füzetek, XV (1892), p. 32, t. i, f. 2.

Test ovoid, inclining to spheroid, in transverse, or oral view, circular; with a broadly-rounded crown furnished with a variable number of conical spines; narrower at the mouth (which in the side view is more or less convex); the mouth central, circular, its border multidentate, or multilobate, with a variable number of small, but perfectly regular divisions, numbering from 12 to 20. Structure of the shell, as in *D. lobostoma* Leidy, incrusted with fine sand-grains, and opaque. Protoplasm colourless; the pseudopodia numerous, long and rather thin, with a tendency to branch or bifurcate.

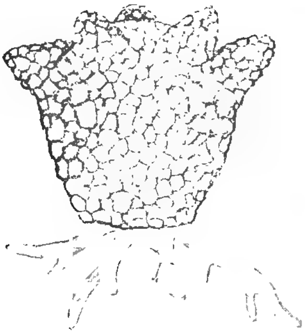


FIG. 65.—A peculiar form of *Difflugia corona* with rounded spines and a large aperture, from Llyn Llydaw, Snowdon. From a drawing by G. S. West. × 200.

Dimensions: Length 180–230 μ; breadth about 150 μ.

In ditches and ponds, not common. Richmond Park, Surrey, associated with *D. urceolata* and other forms. Epping Forest, Essex (*D. J. Scourfield*). Llyn Llydaw, and pools on y Foel Fras, N. Wales; also in the Hebrides (*G. S. West*).

A very distinct species, smaller than *D. urceolata* Carter, but larger than *D. lobostoma* Leidy, from which it differs in size, in the character of the mouth, and in the spined crown. The latter species rarely has a mouth more than four-lobed, and taking all the characters into account there does not seem any ground for supposing that the two species (*D. corona* and *D. lobostoma*) are specifically related, however much the form of the mouth might suggest it. *D. corona* is the handsomest species of the genus.

21. **Difflugia oviformis** sp. nov.

(Plate XX, figs. 8–12.)

Difflugia lobostoma Leidy (pars) Freshw. Rhiz. N. Amer. (1879), p. 112, t. xv, ff. 16, 17.

Test ovoid, beautifully symmetrical and smooth, with a broadly-rounded crown not compressed, the sides curving gracefully downwards to the rather narrow (usually) quadrilobate mouth which is furnished with an expanded wavy collar of thin chitinous substance and has a wavy outline, following the sinuosities of the aperture, which is rarely five-lobed. The whole structure lightish-brown in colour, getting darker with age, covered externally with elongated rectangular scale-like particles, thickly and irregularly set, with little or no incrustation of any other kind. The plasma, visible through the test-walls, not entirely filling the cavity; connected with the fundus by threads of ectoplasm. The nucleus single, situated posteriorly; pseudopodia numerous, colourless, simple or sparingly branched.

Dimensions: Length 110 μ; breadth 80 μ.

In wet moss at pond sides and on trees near the water's edge, Chelford, Cheshire.

This pretty rhizopod is very uncommon. Its occurrence appears to be sporadic, and in the above-named locality—the only one we at present know of—it occurred in the summer of 1905 in extraordinary abundance. Apart from the occasional five-lobed mouth the test showed very little variation in the scores of individuals examined. Every drop of water squeezed from a tuft of *Hypnum*, which was found growing on the half-submerged trunk of a tree, yielded from two to half-a-dozen perfect examples. They were preserved in a living and active state for many months.

This rhizopod differs from *D. amphora* Penard ('Les Sarc. des grands Lacs,' 1905), in size, being considerably smaller (110 μ as compared with 200–210 μ), as well as in the character of the crown and in the general structure of the test. The organism is very mobile. In size and general character it resembles a form included by Leidy in *D. lobostoma*, and so figured in 'Freshw. Rhiz. N. Amer.,' but the structure of the mouth, no less than the surrounding collar, places it beyond the limits of that species.

A rhizopod with which *D. oviformis* might be confounded more readily than with *D. lobostoma* is *Cucurbitella mespiliformis* Penard, a species up to the present time not known in Britain. It has a very similar wavy collar round the mouth. The mouth however is a circular orifice—not lobed—and it has a finely dentate margin; the test, moreover, is stouter in proportion than that of *D. oviformis*, and the elements of which it is composed have no resemblance to those of the species under notice.

22. **Difflugia arcula** Leidy.

(Plate XXII, figs. 8–11.)

Difflugia arcula LEIDY (pars) Freshw. Rhiz. N. Amer. (1879), p. 116, t. xvi, ff. 30, 31; in Pr. Acad. Philad. 1879, p. 163; and *op. cit.* 1880, pp. 335, 338; HITCHCOCK Synops. Freshw. Rhiz. (1881), p. 14; TARÁNEK in Sitzber. böhm.

Ges. Wiss. 1881 (1882), p. 227; GREEFF in Sitzber. Ges. Nat. Marburg, 1888, p. 107; HARVEY in Amer. Natur. XXII (1888), p. 72 (as *ascula*); CERTES in Mission scient. Cap. Horn, VI (1889), 3, Prot., p. 13; PENARD (pars) in Mém. Soc. Genève, XXXI (1890), 2, p. 148, t. iv, ff. 92, 94–96, 98, 99; in Amer. Natur. XXV (1893), p. 1071?; in Arch. Sci. nat. (4) VII (1899), p. 268; Faune Rhiz. Léman (1902), p. 296, ff. 1–4 (p. 297); and in Jrn. R. Micr. Soc. 1907, p. 277; CASH in Tr. Manch. Micr. Soc. 1891 (1892), p. 48; LEVANDER in Acta Soc. Fauna Fenn. XII (1894), 2, p. 18; and *op. cit.* XX (1901), 8, pp. 8, 10; DADAY in Termész. Füzetek, XXI (1898), Suppl. pp. 6, 9; EYFERTH Naturgesch. mikr. Süsswass. ed. 3 (1900), p. 263; LAGERHEIM in Förh. Geol. Fören. Stockholm, XXIII, 6 (1901), p. 472; AVERINTZEV in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 181; SCHOUTEDEN in Ann. Biol. Lacustre, I, 3 (1906), pp. 341, 344; MURRAY in Ann. Scott. Nat. Hist. 1907, p. 94.

Test hemispherical, with a slightly concave base, the crown regularly arched, incrusted with fine sandy or muddy particles, opaque; the mouth (inferiorly situated) triangular or irregularly trilobed, or roughly quadrangular, and never invaginated as in *Arcella*. Nucleus single; pseudopodia normal [?].

Dimensions: Diameter of base about 90 μ; elevation of crown 40–45 μ.

In marshy places; also in tufts of moss and liverwort growing on moist rocks; and in shady woods; frequent.

The form with triangular mouth is probably the one most frequent with us. Occasionally in *Sphagnum* the mouth is irregularly quadrate. In no case is the rim inverted as in some examples figured by Leidy, which belong to *Centropyxis*.

23. **Difflugia constricta** (Ehrenb.) Leidy.

(Plate XIX, figs. 14–20; Pl. XXII, figs. 12–14; and figs. 66–69 in text.)

Arcella constricta EHRENBERG in Abh. Akad. Wiss. Berlin, 1841, p. 410, t. iv, f. 35, and t. v, f. 1; *op. cit.* 1871

(1872), p. 144; in Ber. Akad. Wiss. Berlin, 1853, p. 332; and Mikrogeol. (1854), t. xxxix, *infra*, f. 3.

Difflugia proteiformis sub.-sp. *marsupiformis* Wallich in Ann. Nat. Hist. (3) XIII (1864), p. 241, t. xv, f. 5 *a*, t. xvi, ff. 3–5; Leidy in Pr. Acad. Philad. 1877 (1878), p. 307; Lagerheim in Förh. Geol. Fören. Stockholm, XXIII (1901), p. 512.

Difflugia proteiformis sub.-sp. *marsupiformis* var. *cassis* Wallich in Ann. Nat. Hist. (3) XIII (1864), p. 241, t. xv, f. 5 *b*, *c*; t. xvi, f. 6; Leidy in Pr. Acad. Philad. 1877 (1878), p. 321.

Arcella (*Homœochlamys*) *constricta* Ehrenberg in Abth. Acad. Wiss. Berlin, 1871, p. 244.

Difflugia constricta Leidy (pars) Freshw. Rhiz. N. Amer. (1879), p. 120, t. xviii, ff. 1–36, 45–57; in Proc. Acad. Philad. 1879, p. 163; and *op. cit.* 1880, pp. 335, 338; Hitchcock Synops. Freshw. Rhiz. (1881), p. 15; De Tarr in Rep. N. York State Mus. XXXV (1884), p. 166?; Daday in Ertesz. math. termész. Akad. Budapest, III (1885), p. 161; and in Sitzber. Acad. Wiss. Wien, CXII, 1 (1903), p. 140; Blochmann Mikr. Thierw. Süsswass. (1886), p. 13, t. i, f. 14; ed. 2 (1895), p. 16, t. i, f. 18; Imhof in Jahresb. nat. Ges. Graubünd. XXX (1887), p. 65; Zool. Anzeig. XI (1888), p. 565; and in Arch. Sci. nat. (3) XXX (1893), pp. 649, 650; Greeff in Sitzber. Ges. Nat. Marburg, 1888, 3, p. 108; Guerne Excurs. zool. Fayal et San Miguel (1888), pp. 32, 72; Sacchi in Boll. Scient. III, an. 11 (1889), p. 68; and in Jrn. Microg. XIV (1890), p. 109; Penard in Mém. Soc. Genève, XXXI (1890), 2, p. 148, t. v, ff. 1–16; in Jahrb. nassau. Ver. Naturk. XLIII (1890), p. 70; in Arch. Sci. nat. (3) XXVI (1891), p. 143; *op. cit.* (4) VII (1899), p. 262 etc.; in Amer. Natur. XXV (1893), p. 1070 etc.; Faune Rhiz. Léman (1902), p. 298, ff. 1–16 (p. 299); in Arch. Protist. II (1903), p. 256; and in Pr. R. Soc. Edinb. XXV (1905), p. 594; Frenzel in Arch. mikr. Anat. XXXVIII (1891), p. 12; Rhumbler in Zeits. wiss. Zool. LII, 4 (1891), p. 518; and *op. cit.* LXI, 1 (1895), pp. 38, 46; Cash in Tr. Manch. Micr. Soc. 1891 (1892), p. 48; Levander in Arch. Ver. Mecklenb. XLVI (1892), p. 114; in Zool. Anzeig. XVII (1894), p. 210; in Acta Soc. Fauna Fenn. XII (1894), 2, p. 18; and *op. cit.* XX (1901), 5, p. 7 etc., and 6, p. 5; Lord in Tr. Manch. Micr. Soc. 1891 (1892), p. 55; Schewiakoff in Mém. Acad. Sci. St. Pétersb. (7) XLI (1893), 8, p. 98; Zacharias in Forschb. zool. Stat.

Plön, I (1893), p. 3; and *op. cit.* II (1894), p. 57; Zschokke in Verh. nat. Ges. Basel, XI, 1 (1895), p. 59 etc.; Daday in Termész. Füzetek, XX (1897), p. 153; and *op. cit.* XXI (1898), Suppl. pp. 5, 9; Francé in Res. wiss. Erforsch. Balatons. II (1897), 1, pp. 3, 8; Frenzel in Bibl. Zool. IV, 12 (1897), p. 148, t. ix, f. 7; Fuhrmann in Rev. Suisse Zool. IV (1897), p. 494 etc.; Schaudinn in Deutsch-Ost-Africa, IV, 2 (1897), 19, p. 9; Scourfield in Pr. Zool. Soc. 1897, p. 787; André in Jahresb. nat. Ges. Graubünd. XLI (1898), p. 57 etc.; Stenroos in Acta Soc. Fauna Fenn. XVII (1898), 1, pp. 35, 81; Averintzev in Trudui S.-Peterb. Obshch. XXX, 1 (1900), p. 209; *op. cit.* XXXVI (1906), 2, p. 216; in Ber. Süsswass. nat. Ges. St. Petersb. I (1901), p. 212; and in Zool. Anzeig. XXXI (1907), pp. 244, 309; Eyferth Naturgesch. mikr. Süsswass. ed. 3 (1900), p. 263; Godet in Bull. Soc. Neuchâtel, XXVIII (1900), p. 77; Lagerheim in Förh. Geol. Fören. Stockholm, XXIII, 6 (1901), p. 510 etc.; and *op. cit.* XXIV (1902), p. 246 etc.; G. S. West in Jrn. Linn. Soc., Zool. XXVIII (1901), p. 317; and in Ann. Scott. Nat. Hist. 1905, p. 89; Beardsley in Tr. Amer. Micr. Soc. XXIII (1902), p. 57; Kofoid in Bull. Illinois State Lab. VI, 2 (1903), p. 526; Zykoff in Bull. Soc. Nat. Moscou, XVII (1903), p. 16; Forel Le Léman, III (1904), p. 138; Cushman in Amer. Natur. XL (1906), p. 172; Edmonston in Pr. Davenport Acad. Sci. XI (1906), p. 14, t. iii, f. 14; Schorler & Thallwitz in Ann. Biol. Lacustre, I, 2 (1906), p. 260; Schouteden in Ann. Biol. Lacustre, I, 3 (1906), pp. 340, 348; Thiebaud in Zool. Anzeig. XXIX (1906), p. 796; Murray in Ann. Scott. Nat. Hist. (1907), p. 94; Le Roux in Ann. Biol. Lacustre, II, 1 (1907), p. 264; Zschokke in Arch. Hydrobiol. II (1907), 1, p. 4; Schneider in Arch. Biontol. II, 1 (1908), p. 58.

Difflugia marsupiformis Bütschli in Bronn's Thier-Reichs, I, 1 (1880), t. iii, ff. 2, 3; Penard in Jahrb. nassau. Ver. Naturk. XLIII (1890), p. 70; and in Rev. Suisse Zool. XXXI (1890), 2, p. 143, t. iv, ff. 30–33; Lagerheim in Förh. Geol. Fören. Stockholm, XXIII (1901), p. 512.

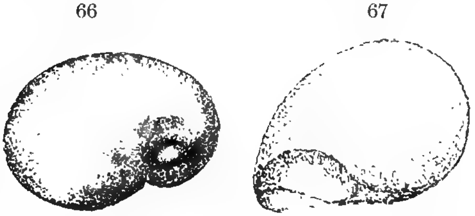
Difflugia (*Arcella*) *constricta* Certes in Mission scient. Cap. Horn, VI, 3 (1889), p. 13.

Difflugia platystoma Penard in Rev. Suisse Zool. XXXI (1890), 2, p. 143, t. iv, ff. 35–37.

Test very variable in size and form, distinguished from other species by its antero-inferior mouth, the position of which is always excentric; the structure rounded posteriorly, and sometimes furnished with two or more spines (curved or straight) as in *Centropyxis.* The mouth circular or oval, its edges more or less inverted, with the anterior lip prominent. The chitinous test colourless, yellowish, or brown, and covered with irregular scales, large and small intermixed, or with sand-grains or other extraneous particles. Plasma-body transparent, colourless, or crowded with small yellowish or greenish granules. Pseudopodia normal.

Dimensions: Variable [; 30–125 μ (Penard)].

In the ooze of ponds; in marshy ground, and on moist rocks, amongst *Sphagnum* and other aquatic mosses; extremely common.



Figs. 66 and 67.—Lateral views of *Difflugia constricta.* × 300.

This is one of the most variable of the *Difflugiæ,* and the limits of the species are by no means well-defined. Between an example figured (Pl. XIX, fig. 18), which is the largest as well as the most perfect we have met with, and the minute *Sphagnum*-loving forms, there is every possible gradation. Some spined varieties indeed approach so closely to *Centropyxis aculeata* in form and general structure, if not in size, as to suggest an affinity between them; but it would hardly be safe to say that they are connected by a series of intermediate forms.

The species is cosmopolitan and it is more than probable that its variable character is induced by the surrounding conditions. Ponds may be said to yield more perfect examples (though they are less common) than *Sphagnum*-bogs; but in the latter are to be found numerous pretty varieties, both spined and spineless. Some spined forms might probably be ranked as permanent varieties, but the task of separation would be endless and unprofitable. There is great force in Penard's observation that it seems more natural to consider the name *Difflugia constricta* Ehrenb. as applying to a group of forms which it is impossible for the present to differentiate as distinct varieties. One impediment to their study is the infrequency of living examples as compared with the multitudes of empty tests. One filose protoplast, at least — *Corythion platystomum* sp. nov. — simulates *D. constricta* in the form of its test, and might easily be confounded with it in the absence of the living organism.

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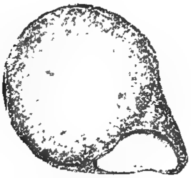

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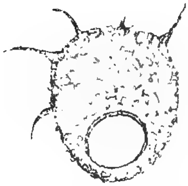

Fig. 68.—Oblique view of ordinary form of *Difflugia constricta*. × 300.
Fig. 69.—Front view of spined form of the same. × 320.

Small spineless forms of *D. constricta* occur in nearly every tuft of moss found growing in moist places. Where the supply of moisture is intermittent the tests have always a depauperated appearance.

Genus 19. **PONTIGULASIA** Rhumbler, 1895.

Difflugia (pars) Carter in Ann. Nat. Hist. (3) XIII (1864), p. 22.

Pontigulasia Rhumbler in Zeits. wiss. Zool. LXI, 1 (1895), p. 105.

Test similar in construction to that of *Difflugia*, but differing from it in two marked features, namely, a constriction of the neck situated a little distance above the mouth, and the possession of an internal transverse loop, or diaphragm, extending from side to side coextensively with the constriction, and of the same substance as the test, or adhering all round its sides, and perforated for the emission of the pseudopodia.

The organism named and figured by Leidy, first as *Difflugia vas*, and afterwards as *D. pyriformis* var. *vas* (*Pontigulasia spectabilis* Penard), may be taken as typical of the genus. It was, in fact, created to receive that particular form, but others have since been added.

1. **Pontigulasia vas** (Leidy) Schouteden.*

(Plate XXIII, fig. 1; and figs. 70 and 71 in text.)

Difflugia vas Leidy in Proc. Acad. Philad. 1874, p. 155; and *op. cit.* 1875, p. 307; Certes in Mission scient. Cap. Horn, VI (1889), Zool. 3, p. 13; Cash in Tr. Manch. Micr. Soc. 1891 (1892), p. 48.

Difflugia pyriformis var. *vas* Leidy Freshw. Rhiz. N. Amer. (1879), pp. 99, 101, t. xii, ff. 2–9; Hitchcock Synops. Freshw. Rhiz. (1881), p. 12; Penard in Mém. Soc. Genève, XXXI (1890), 2, p. 137, t. iii, ff. 39–41; and in Rev. Suisse Zool. VII, 1 (1899), t. ii, f. 9; Schaudinn in Deutsch-Ost-Africa, IV, 2 (1897), 19, p. 9; Averintzev in Ber. Süsswass. Nat. Ges. St. Petersb. I (1901), p. 212; Lagerheim in Förh. Geol. Fören. Stockholm, XXIII, 6 (1901), p. 503; G. S. West in Jrn. Linn. Soc., Zool. XXVIII (1901), p. 318; Thiebaud & Favre in Ann. Biol. Lacustre, I, 1 (1906), pp. 76, 79.

Difflugia pyriformis Leidy (pars), Freshw. Rhiz. N. Amer. (1879), p. 102, t. xix, ff. 24–26.

Pontigulasia spectabilis Penard Faune Rhiz. Léman (1902), p. 318, ff. 1–9 (p. 319); Averintzev in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 167.

Pontigulasva vas Schouteden in Ann. Biol. Lacustre, I, 3 (1906), p. 338 (note).

Test in lateral view round or ovoid, not compressed, the constriction deep and well-marked, sometimes fortified by comparatively large quartz-grains; the neck oval, or, from a slight inflation immediately below the constriction tapering down to the narrowed and truncated mouth. Surface of the test more or less thickly incrusted with sand-grains and other material; in some examples comparatively smooth.

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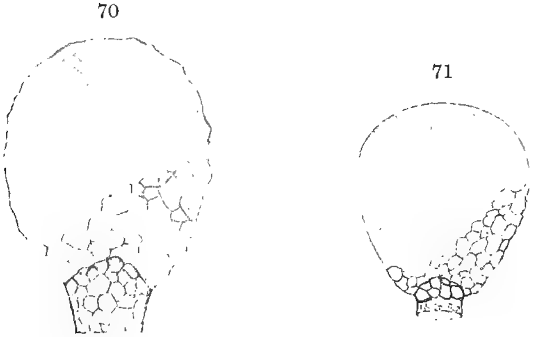
* [*Pontigulasia spectabilis* Penard: Cash, MS.]

Dimensions: Length 125–170 μ.

Amongst sub-aquatic mosses at pond-sides, and in wet *Sphagnum* in marshy places, not frequent. Padgate near Warrington; near Towyn, Merionethshire. New Forest, Hants, and Llyn Idwal, N. Wales (*G. S. West*). Nant Francon, N. Wales (*J. Hopkinson*).



Figs. 70 and 71.—*Pontigulasia vas:* 70, from Llyn Idwal, N. Wales, × 100; 71, from the New Forest, Hants, × 60. From drawings by G. S. West.

Prof. G. S. West, in the Linnean Society's 'Journal,' vol. xxviii (Zool.), p. 318, records the dimensions of examples found in the New Forest as 470 μ in length and 380 μ in breadth, and those from Llyn Idwal, he states, were approximately of the same size. These dimensions very much exceed those given by Penard for the species. But it is a variable one. The example figured on Plate XXIII (fig. 1) from Padgate, was remarkably fine and well-formed, but whilst the constriction was deep and clearly defined, the form differed from Penard's figure of "*P. spectabilis*" in having the sides of the neck (from the constriction downwards to the mouth) evenly convex instead of straight. There were no isolated quartz-grains on any part of the structure, which was smooth, and, like the incrusted *Difflugiæ*, opaque. Penard, in 'Faune Rhiz. Léman,' figures the diaphragm with four perforations.

2. **Pontigulasia bryophila** Penard.

(Pl. XXIII, fig. 2.)

Pontigulasia bryophila Penard Faune Rhiz. Léman (1902), p. 324, ff. 1–4; Averintzev in Trudui S.-Peterb. Obshch. XXXVI (1906), p. 168; Schouteden in Ann. Biol. Lacustre, I, 3 (1906), p. 338.

Smaller and of more graceful proportions than the preceding; body of the test oval, not compressed; the constriction deep, sometimes fortified with quartz-grains of large size; the neck, from a slight inflation, converging in straight lines to the truncated mouth. General structure as in *P. vas*, with, however, an admixture of amorphous (siliceous ?) scales on the surface, or these scales exclusively. Pseudopodia as in the preceding species.

Dimensions: Length 120–135 μ; breadth 70 μ.

In wet *Sphagnum*, near Towyn, N. Wales, 1905. Killough, Co. Wicklow, Ireland, 1908 (*J. Hopkinson*).

This appears to be a rarer form than the preceding. The Towyn locality, and more recently that in Co. Wicklow, are the only ones where we can say with reasonable certainty that it has been found in this country. The limits which separate the species from *P vas* are not great—it may be that the two are connected by intermediate forms, but the number of individuals found do not admit of any confident opinion being expressed upon the point. *P. bryophila*, however, may be distinguished from its neighbour (following Penard's description) by its elliptic, never rotund or sub-rotund body. It may be remarked that the general outline of both this and the preceding species, apart from the constriction which is characteristic of

Pontigulasia, is that of the commoner forms of *Difflugia oblonga* Ehrenb.

3. **Pontigulasia compressa** (Carter).

(Plate XXIII, figs. 3–5; and fig. 72 in text.)

Difflugia compressa CARTER in Ann. Nat. Hist. (3) XIII (1864), p. 22, t. i, ff. 5, 6; PARFITT in Tr. Devon Assoc. III (1867), p. 66.

Difflugia pyriformis var. *vas* sub-var. *bigibbosa* PENARD in Rev. Suisse Zool. VII, 1 (1899), p. 26, t. ii, f. 10.

Pontigulasia bigibbosa PENARD Faune Rhiz. Léman (1902), p. 322, ff. 1–3 (p. 323); Sarc. grands Lacs (1905), p. 35, f.; and in Pr. R. Soc. Edinb. XXV, 8 (1905), p. 595; ZSCHOKKE in Arch. Hydrobiol. II, I (1906), p. 4.

(Non *Pontigulasia compressa* RHUMBLER in Zeits. wiss. Zool. LXI, 1 (1905), p. 105, t. iv, f. 13.)

Test large, roundish pyriform, nearly as broad as long, and unequally compressed; the body, or upper three-fourths (above the constriction) broadly reniform, its convex surface forming the crown of the test, whilst the outline of the concavity—in empty tests usually sharply defined, and coterminous with the constriction—marks the junction with the neck, which is more strongly compressed and is substantially less dense than the bi-gibbous lower surface of the body. Sides of the neck tapering evenly downwards to the comparatively narrow truncated mouth, of which the orifice is round or broadly elliptical in outline. Body constructed of minute quartz-grains, and rough on the surface; the neck less so, and lighter in colour. A doubly perforated diaphragm (figured by Penard in 'Faune Rhiz. Léman') crowning the test internally at the point of constriction. Nucleus single; protoplasm and pseudopodia normal.

Dimensions: Length 130–150 μ; breadth about 100 μ. Penard records examples from Lake Léman 250 μ in length.

In wet *Sphagnum*, in boggy places, also in the deep water of lakes. Dunham, Cheshire, 1904;

also near Criccieth and in the Sychnant Pass, North Wales. South Devon, 1864 (*H. J. Carter*). Loch Ness (*D. J. Scourfield*). Killough, Co. Wicklow, Ireland (*J. Hopkinson*).

This species can hardly be considered rare in Britain. It is of frequent occurrence in the localities mentioned, and doubtless in most situations of a similar character throughout the country. It seems to flourish indifferently in *Sphagnum*-bogs, in damp ditches where *Sphagnum* is found (as in the neighbourhood of Criccieth), and in the deep waters of lakes. It is recorded by D. J. Scourfield from Loch Ness, Scotland, at depths of 272 and 680 feet; and Penard finds it in Lake Léman, Geneva, at 20-40 metres depth. Examples taken at Dunham, Cheshire, in 1903, were blackish opaque, and so thickly incrusted with sand-grains as almost to obscure the constriction and render identification difficult. Individuals were very active, and might have been mistaken for coarse *Difflugiæ* but for the unequally compressed test.

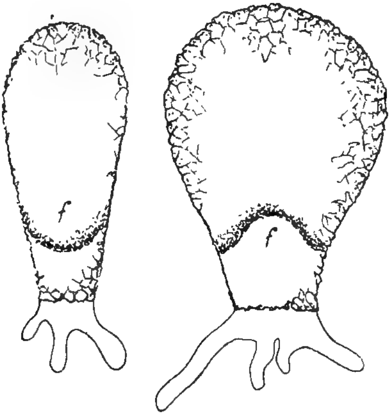


FIG. 72.—Lateral views (narrow and broad) of *Pontigulasia compressa*. After Carter, *loc. cit.* × about 280. *ff.* "Dark, collar-like mark at the base of the neck of the test" (*Carter*).

The species was first observed by Carter at Budleigh-Salterton, in "heath-bog water," among conjugating confervoid algæ and desmids. Assuming it to be a species of *Difflugia* he gave it the specific name of *compressa*. Penard's more recent researches show that it rightly belongs to his genus *Pontigulasia*, and it has become familiar under the name of *P. bigibbosa* Penard; but we feel bound to revert to Carter's original specific name, notwithstanding the fact that another and quite different form, found on the continent, has recently received from Rhumbler the name of *Pontigulasia compressa*. Carter's figures in 'Ann. and Mag. Nat. Hist.,' ser. 3, vol. xiii, plate I, place beyond question the identity of *Difflugia compressa* with the *Pontigulasia bigibbosa* of Penard.

[Var. **flexa** *var. nov.* (Plate XXIII, figs. 6 and 7.)

Test narrower in proportion to its length, and with a much more oblique aperture than in the type, the neck having a considerable lateral flexure, and the aperture forming an angle of about 45 degrees with the general axis of the test. Surface of test much smoother than in the type.

Dimensions: Length 140 μ; breadth in front view 80 μ, in lateral view 60 μ; diameter of aperture 25 μ.

In *Sphagnum*-pool, Moel Siabod, N. Wales, at 2500 ft., June, 1908 (*J. Hopkinson*).

Empty tests only were found, but they differ so much from those of *Pontigulasia compressa* as hitherto seen that the form appears to merit at least varietal rank; an opinion evidently held by Mr. Cash, who made the following brief remarks upon it:— "*bigibbosa* ? var." "Mouth oblique (more so than in the type)." "Probably distinct."

This and all the other rhizopods for which the locality Moel Siabod is given were found in a small sphagnous bog-pool just under the rocky peak overlooking Capel Curig, the source of a rivulet apparently the highest on the mountain.]

Genus 20. **LESQUEREUSIA*** Schlumberger, 1845.

Difflugia (pars) Leclerc in Mém. du Mus. II (1815), p. 477.
Lecquereusia Schlumberger in Ann. Sci. nat., Zool. (3) III (1845), p. 255.

Test compressed, ovoid or globose in side view, narrowed at the neck; the latter unsymmetrical and so joined to the body as to give the structure more or less the appearance of a semi-spiral, or it may be tangentially posed with a slight curve. The test, both neck and body, composed of transparent chitinous membrane with an interlacing pattern of minute curved or comma-shaped rods, or (in one species) incrusted with sand-grains, and opaque. The internal cavity only partially filled by the plasma; a stream of ectoplasm from the main body traversing the neck, and reaching the orifice through an aperture formed by the constriction.

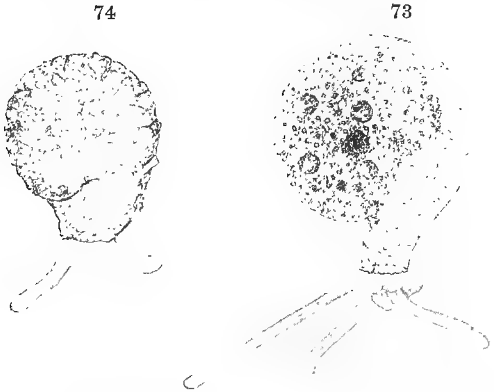


Fig. 73.—"*Lesquereusia spiralis*" Ehrenb. (? truly *L. jurassica* Schlumb.).
Fig. 74.—"*L. modesta*" Rhumbl. (? truly *L. spiralis* Ehrenb.). Both from Dunham Marsh, Cheshire. × about 250.

[The names *Lesquereusia spiralis* and *L. modesta* are here retained for the two following species with much doubt, for they appear to have been misapplied. Ehrenberg in 1840 described his *Difflugia spiralis* thus:— "D. lorica subglobosa spirali, superficie inæquali, pseudopodiis numero variis hyalinis." Schlumberger in 1845 described as *Lecquereusia jurassica* a form which is certainly that now known as *L. spiralis*.* Ehrenberg in 1872 accepted Schlumberger's species and gave figures of his own species (*spiralis*) representing it as sand-covered and much less elegant in form than Schlumberger's *L. jurassica*, thus confirming his previous description of it as having an uneven surface (due to the sand-particles). Rhumbler in 1895 assigned the elegant and comparatively smooth form with "vermiform pellets" (as Leidy called them) and transparent test to *L. spiralis*, and named the less elegant rough form with sand-particles and opaque test, *L. modesta*. He was almost certainly in error in doing so, and should have adopted for the elegant form the name *L. jurassica* Schlumb., and for the less elegant one that of *L. spiralis* Ehrenb. To change these names now would create such confusion that advantage is taken of the slight doubt which exists as to the necessity of doing so. The synonymy of the two species is much involved, and probably several references given under *Lesquereusia spiralis* should be transferred, in whole or part, to *L. modesta*.]

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* [Dr. Penard has pointed out that the genus was named after the Swiss naturalist Lesquereux, this therefore being the correct spelling.]

1. **Lesquereusia spiralis** (Ehrenberg) Bütschli.

(Plate XXIII, fig. 8; and figs. 73 and 75 in text.)

Difflugia LECLERC ? (pars) in Mém. du Mus. II (1815), p. 447, ff. 1, 4 (*non* f. 1 a).

Difflugia spiralis EHRENBERG ? in Monatsb. Akad. Wiss. Berlin, 1840, p. 199; BAILEY in Smithson. Contrib. II (1851), 8, p. 41 etc.; PRITCHARD Hist. Infus. new ed. (1852), p. 208; and ed. 4 (1861), p. 553; FRESENIUS

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* His description is: "Animal à têt résistant, diahpane, grisâtre, en forme de cornue globuleuse un peu déprimée; à cou large et court; comme composé d'une pâte de petits corps bacillaires. Longeur, environ 0·1; largeur, 0·083; épaisseur, 0·066 [mm.]." He states also that the test is diaphanous so that the body can be easily seen in the interior. This is the earliest clear definition of the species.

(pars) in Abh. Senkenb. nat. Ges. II (1858), p. 224, t. xii, ff. 37–42; Claparède & Lachmann Études Inf. et Rhiz. 2 (1859), p. 448; Carter (pars) in Ann. Nat. Hist. (3) XIII (1864), p. 29; Wallich in Ann. Nat. Hist. (3) XIII (1864), pp. 224, 225; Archer in Q. Jrn. Micr. Sci. (n.s.) VI (1866), p. 185; *op. cit.* VIII (1868), p. 68; in Jrn. Dublin Micr. Club, I, 2 (1867), p. 51; and *op. cit.* I, 3 (1868), p. 161; Parfitt in Tr. Devon Assoc. III (1869), p. 66; Leidy (pars) in Pr. Acad. Philad. 1874, p. 79; *op. cit.* 1877 (1878), p. 307; and 1879, p. 162; and Freshw. Rhiz. N. Amer. (1879), p. 124, t. xix, ff. 1–22; Eyferth Naturgesch. mikr. Süsswass. (1877), p. 25; ed. 2 (1885), p. 51, t. iii, f. 31; and ed. 3 (1900), p. 263; Mereschowsky in Trudui S.-Peterb. Obshch. VIII (1877), p. 314, t. i, f. 15; and in Arch. mikr. Anat. XVI (1879), p. 183, t. x, f. 15; Hitchcock Synops. Freshw. Rhiz. (1881), p. 16; De Tarr in Rep. N. York State Mus. XXXV (1884), p. 167; Bolton in Midl. Natur. IX (1886), p. 174; Fielde in Pr. Acad. Philad. 1887, p. 122; Guerne Excurs. zool. Fayal et San Miguel (1888), p. 32; Imhof in Zool. Anzeig. XI (1888), p. 565; Gruber ? in Zacharias' Tierw. Süsswass. (1891), I, p. 139, f. 16 (3) (p. 140); Rhumbler in Zeits. wiss. Zool. LII, 4 (1891), p. 523 etc. ?; LXI, 1 (1895), p. 96 etc., t. iv, ff. 1, 3, 4, and text-f. 9 (p. 97); Cash in Tr. Manch. Micr. Soc. 1891 (1892), p. 55; Lord in Tr. Manch. Micr. Soc. 1891 (1892), p. 55; Zschokke in Ver. nat. Ges. Basel, XI, 1 (1895), p. 75 etc.

Lecquereusia jurassica Schlumberger in Ann. Sci. nat., Zool. (3) III (1845), p. 255; Ehrenberg in Abh. Akad. Wiss. Berlin, 1871 (1872), p. 235; Penard (pars) in Mém. Soc. Genève, XXXI (1890), 2, p. 156, t. vi, ff. 10–20; in Amer. Natur. XXV (1893), pp. 1071, 1074; and in Arch. Sci. nat. (3) XXIX (1893), p. 179, t. iii, ff. 10, 12; Godet in Bull. Soc. Neuchâtel, XXVIII (1900), p. 77.

Difflugia helix Cohn (? pars) in Zeits. wiss. Zool. IV, 3 (1853), p. 261.

Difflugia proteiformis var. *septifera* Wallich in Ann. Nat. Hist. (3) XI (1863), p. 453, t. x, f. 12.

Difflugia proteiformis Wallich in Ann. Nat. Hist. (3) XII (1863), p. 456.

Difflugia proteiformis sub-sp. *mitriformis* var. *spiralis* Wallich in Ann. Nat. Hist. (3) XIII (1864), p. 240, t. xv, f. 3 *v*; t. xvi, ff. 24, 25.

Difflugia (*Corticella*) *spiralis* Ehrenberg ? in Abh. Akad. Wiss. Berlin, 1871 (1872), pp. 247, 274, t. iii, 1, ff. 25–27.

Lecquereusia (*Difflugia*) *spiralis* Bütschli in Bronn's Thier-Reichs, I, 1 (1880), t. iii, f. 9.

Lecquereusia spiralis Taránek (pars) in Sitzber. böhm. Ges. Wiss. 1881 (1882), p. 228; and in Abh. böhm. Ges. Wiss. (6) XI (1882), 8, p. 49, t. v, ff. 1, 2, 4, 6–11, 13–15, ? 16; Blochmann Mikr. Thierw. Süsswass. (1886), p. 13, t. i, f. 28; and ed. 2 (1895), p. 17, t. i, f. 21; Lendenfeld in Pr. Linn. Soc. N. S. Wales, X (1886), p. 724; and in Tr. R. Soc. N. S. Wales; Rhumbler in Zeits. wiss. Zool. LII, 4 (1891), p. 518; and *op. cit.* LXI, 1 (1895), p. 42 etc., t. iv, ff. 1, 3, 4, and text-f. 9 (p. 97); Schewiakoff in Mém. Acad. St. Pétersb. (7) XLI (1893), 8, p. 98; Levander in Acta Soc. Fauna Fenn. XII (1894), 2, p. 19; *op. cit.* XIX (1900), 2, p. 7; and XX (1901), pp. 8, 12; Delage & Hérouard Traité Zool. concr. I (1896), p. 106, f. 129; Schaudinn in Deutsch-Ost-Africa, IV, 2 (1897), 19, p. 10; André in Jahresb. nat. Ges. Graubünd. XLI (1898), p. 57 etc.; Daday in Termész. Füzetek, XXI (1898), Suppl. pp. 5, 9; Stenroos in Acta Soc. Fauna Fenn. (1898), 1, p. 35 etc.; Averintzev in Trudui S.-Peterb. Obshch. XXX, 1 (1900), p. 239; *op. cit.* XXXVI (1906), 2, p. 173; and in Ber. Süsswass. Nat. Ges. St. Petersb. I (1901), p. 214; Lagerheim (pars) in Förh. Geol. Fören. Stockholm, XXIII (1901), p. 514; and *op. cit.* XXIV (1902), p. 348; Penard in Arch. Sci. nat. (4) VII (1899), p. 256 etc.; Faune Rhiz. Léman (1902), p. 326, ff. 1–10 (p. 328); and in Pr. R. Soc. Edinb. XV, 8 (1905), p. 594; G. S. West in Jrn. Linn. Soc., Zool. XXVIII (1901), p. 321; and in Ann. Scott. Nat. Hist. 1905, p. 90; Cushman in Amer. Natur. XL (1906), p. 372; Hartog Prot. in Cambr. Nat. Hist. I (1906), p. 55; Schorler & Thallwitz in Ann. Biol. Lacustre, I, 2 (1906), p. 260; Schouteden in Ann. Biol. Lacustre, I, 3 (1906), p. 339, f. 11; Murray in Ann. Scott. Nat. Hist. 1907, p. 94; Schneider in Arch. Biontol. II, 1 (1908), p. 58.

Test homogeneous; in lateral outline globose or ovoid; slightly compressed, produced into an unsymmetrical neck, and so constricted as to give the impression of a spiral; its membrane chitinous and transparent, with a meshwork of short curved rods, forming minute ridges, closely compacted (described by Leidy as "vermiform pellets"), the neck, below the constriction, with a slight elevation from which the outline is continued in a straight line down to the mouth; the orifice circular, contracted, its margin plain and sharply defined; the surrounding membrane thin. The plasma pale yellow, as seen through the transparent test; nucleus single, situated posteriorly; the pseudopodia as in *Difflugia*, long, blunt, simple, or branched.

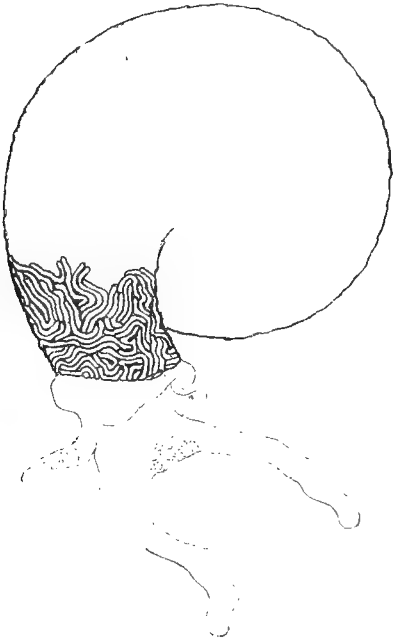

FIG. 75.—*Lesquereusia spiralis*, showing the "vermiform pellets" represented only on part of the test. Terrington, W. Yorks. From a drawing by G. S. West (reduced). × 390.

Dimensions: Average length, including the neck, 120 μ; breadth 95 μ.

In marshes amongst *Sphagnum* and other sub-aquatic vegetation, frequent and universally distributed.

This handsome rhizopod is found most commonly in places where *Sphagnum* abounds, and more especially in lowland bogs. It is very mobile, and readily distinguished from the next species by the transparency of all its parts, the surface of the test being void of extraneous matter. Cosmopolitan in habit and indifferent as to climate, it has been reported from the Rocky Mountains and other parts of North America, from all parts of the European Continent, and even from Australia. Referring to the test, Leidy, in 'Freshw. Rhiz. N. Amer.,' says: "Though not strictly correct to call it spiral, the constriction of the neck, especially when viewed by transmitted light, gives rise to such an impression; and this led Ehrenberg so to name it, and likewise Bailey after him, apparently without knowing that the former had done so."

2. **Lesquereusia modesta** Rhumbler.

(Plate XXII, fig. 15; Pl. XXIII, fig. 9; and figs. 35 and 74 in text.)

Difflugia Leclerc (pars) in Mém. du Mus. II (1815), p. 447, t. xvii, f. 1 a (? ff. 1, 4).

Difflugia spiralis Ehrenberg ? in Monatsb. Akad. Wiss. Berlin, 1840, p. 199.

Difflugia proteiformis monstrosa Perty Kenntn. kleinst. Lebensf. (1852), p. 187, t. viii, f. 22.

Difflugia helix Cohn (? pars) in Zeits. wiss. Zool. IV, 3 (1853), p. 261.

Difflugia spiralis Fresenius (pars) in Abh. Senkenb. nat. Ges. II (1858), p. 224; Carter (pars) in Ann. Nat. Hist. (3) XIII (1864), p. 29, t. i, f. 9; Leidy (pars) Freshw. Rhiz. N. Amer. (1879), p. 127, t. xix, f. 23; Edmonston in Pr. Davonport Acad. Sci. XI (1906), p. 16, t. iii, f. 18; Landacre in Pr. Ohio Acad. Sci. IV, 10 (1908), p. 428.

Difflugia (*Corticella*) *spiralis* Ehrenberg? in Abh. Akad. Wiss. Berlin, 1871 (1872), pp. 247, 274, t. iii, 1, ff. 25–27.

Lecquereusia spiralis Taránek (pars) in Sitzber. böhm. Ges. Wiss. 1881 (1882), p. 228; and in Abh. böhm. Ges. Wiss. (6) XI (1882), 8, p. 53, t. v, f. 5, 12, ? 17; Rhumbler (pars) in Zeits. wiss. Zool. LII, 4 (1891), p. 523 etc., t. xxxii, ff. 14–17; Lagerheim (pars) in Förh. Geol. Fören. Stockholm, XXIII, 6 (1901), p. 514.

Lecquereusia modesta Rhumbler in Zeits. wiss. Zool. LXI, 1

(1895), p. 101, t. iv, f. 2; PENARD Faune Rhiz. Léman (1902), p. 329, ff. 1–6; and in Pr. R. Soc. Edinb. XXV (1905), pp. 594, 596; AVERINTZEV in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 171; SCHOUTEDEN in Ann. Biol. Lacustre, I, 3 (1906), p. 339.

Test nearly resembling in form that of the preceding species, but incrusted, sometimes very thickly, with sand-grains; opaque; compressed; the neck thicker than in *L. spiralis*, more angular, usually with a broader base, and without the graceful curvature characteristic of that species. Nucleus and pseudopodia normal.

Dimensions: Average length 100 μ; breadth 80 μ.

In boggy places at Dunham and Chelford, Cheshire; amongst *Sphagnum*, Sychnant Pass, Carnarvonshire. Pond at Chipperfield, Herts (*A. Earland*). Above Dolgam, Capel Curig, N. Wales; and Killough, Co. Wicklow, Ireland (*J. Hopkinson*). Loch Ness, Scotland (*D. J. Scourfield*).

This species is less frequent with us than *L. spiralis*; it is found mostly in bogs, occasionally also in ponds, living in the ooze along with the larger forms of *Difflugia*. The test is generally more compressed than that of *L. spiralis*, and the tube or neck thicker and shorter. Examples found by Penard on the margins of some of the Swiss lakes had a variable number of siliceous rods mingled with the quartz-grains which composed the test, but more frequently irregular or rounded plates or membranous scales.

3. **Lesquereusia epistomium** Penard.

(Plate XXIII, figs. 10 and 11; and fig. 76 in text.)

Lecquereusia spiralis TARÁNEK (pars) in Abh. böhm. Ges. Wiss. (6) XI (1882), 8, p. 51, t. v, f. 3.

Lecquereusia jurassica var. *epistomium* PENARD in Arch. Sci. nat. (3) XXVIII (1893), p. 179, t. iii, ff. 11, 13, 14.

Lecquereusia epistomium PENARD Faune Rhiz. Léman (1902), p. 331, ff. 1–3; AVERINTZEV in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 174; and in Arch. Protist. VIII (1906), p. 103, f. 7 (p. 104); SCHOUTEDEN in Ann. Biol. Lacustre, I, 3 (1906), p. 340.

Test chitinous, hyaline, marked similarly to that of *L. spiralis* (the "rods," however, being usually reniform, and stouter), slightly or not at all compressed; its contour, viewed laterally, round or broadly ovoid, the neck appearing in side view as if poised at a tangent, turgid, narrowed at the mouth.

Dimensions: Length 110–125 μ; breadth 75–80 μ.

In wet *Sphagnum*, Dunham, Cheshire, 1905; much less common in Britain than the two preceding species.

This species is distinguished from *L. spiralis* by its smaller, more globose body, and the peculiar position, in relation to it, of the neck (fig. 76). Like *L. spiralis* the animal is very active in its movements, and the pseudopodia have a habit of enveloping the test; sometimes a long stream of ectoplasm will issue from the mouth of the test, and send out from this short subsidiary pseudopodia on both sides. We have only met with the species in the locality above named.

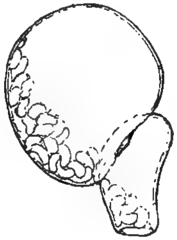

FIG. 76.—Side view of *Lesquereusia epistomium*. × 280.

4. **Lesquereusia inæqualis** *sp. nov.*

(Plate XXIII, fig. 12.)

Larger than average examples of *L. spiralis*, similarly constructed but less elegant, differing mainly in the outline of the test, which is relatively much broader, and in side view is divided roughly by a shallow depression on the dorsal surface into two turgid unequal portions. The measurement across the test in its broadest part exceeds, as a rule, that taken longitudinally from the extremity of the neck to the crown. The test is chitinous, transparent, and covered externally with the same interlacing curved "rods" as in *L. spiralis*—these, if anything, being longer and thinner. It has a short neck, which is sharply truncated; the mouth not contracted. The upper surface of the neck has two slight elevations which give it a wavy outline. Nucleus and pseudopodia as in *L. spiralis*, generally simple.

Dimensions: Length 135 μ (from mouth to summit of test); breadth 125 μ.

At Dunham, Cheshire, amongst *Sphagnum*, 1904 and later, associated with others of this genus.

Were it not for the appearance of this peculiar *Lesquereusia* year by year, we might regard it as an abnormal form of *L. spiralis*. It has, however, characters quite distinct and without variation in the numerous individuals examined. It may be at once differentiated from the last-named species by the peculiar, unequally balanced test. Like others of the genus the animal is usually very active.

Genus 21. **PHRYGANELLA** Penard, 1902.

Difflugia (pars) HERTWIG & LESSER in Arch. mikr. Anat. X (1874), Suppl. p. 107.
Pseudodifflugia (pars) PENARD in Mém. Soc. Genève, XXXI (1890), 2, p. 169.
Phryganella PENARD Faune Rhiz. Léman (1902), p. 418.

Test sub-globose, hemispherical or ovoid, most frequently resembling that of *Difflugia globulus* Ehrenb. and liable to be mistaken for it; incrusted with minute diatom shells and a varying proportion of sand-grains, or the latter exclusively; the mouth inferior, round, symmetrical.

The genus was established by Penard in 1902 to receive certain species which up to that time had been described by Leidy and others as forms of *Difflugia globulus*. Whilst possessing a close resemblance in the structure of the test, they differ from that species in the character of the pseudopodia, which, in their ultimate extremities, are pointed, not blunt.

1. **Phryganella acropodia** (Hertwig & Lesser).*
(Plate XX, figs. 13 and 14.)

Difflugia acropodia HERTWIG & LESSER in Arch. mikr. Anat. X (1874), Suppl. p. 107, t. ii, f. 6; ARCHER in Q. Jrn. Micr. Sci. XXVII (1877), p. 114; and in Jrn. Dublin Micr. Club, III, 2 (1877), p. 232.

Difflugia globulosa LEIDY (pars) Freshw. Rhiz. N. Amer. (1879), p. 96, t. xvi, ff. 23, 24.

Pseudodifflugia hemispherica PENARD in Mém. Soc. Genève, XXXI (1890), 2, p. 169, t. vii, ff. 108–114.

Phryganella hemispherica PENARD Faune Rhiz. Léman (1902), p. 421, ff. 1–5; in Arch. Protist. II (1903), p. 264; and in Jrn. R. Micr. Soc. 1907, p. 278; AVERINTZEV in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 261; SCHOUTEDEN in Ann. Biol. Lacustre, I, 3 (1906), p. 360.

Test hemispherical in side view, yellowish or brownish, semi-transparent, and covered with amorphous scales, and sometimes sparsely with sand-grains; viewed ventrally circular in outline, the mouth occupying about two-thirds of the area, and concentric; nearly always (in the living state) surrounded by flocculent material to a considerable extent obscuring the mouth which is sometimes surrounded by a ring of comparatively large sand-grains. The ectoplasm emerges from the oral aperture often in ribbon-like masses, which divide at their extremities into sharply-cut prolongations of variable length extending radially on all sides when the animal is in active movement. Endoplasm colourless, containing a single nucleus and a variable number of chlorophyll and other particles.

Dimensions: Diameter 30–50 μ.

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* [*Phryganella hemispherica* Penard; CASH, MS.]

In *Sphagnum*. Dunham, Cheshire; near Towyn, and at Criccieth, N. Wales. Killough, Co. Wicklow, Ireland (*J. Hopkinson*).

The resemblance of the test of *Phryganella acropodia* to that of *Difflugia globulus* is so close that in the absence of living examples its presence in any collection cannot be determined with certainty. There is risk also of its being confounded with *Pseudodifflugia gracilis* Schlumb. The three species, whilst differing essentially in other respects, have tests which are cast, so to speak, in the same mould, so that it is impossible to pronounce certainly with regard to any particular test under examination to which of the three it belongs.

Phryganella acropodia is not often met with in the living state; it is most frequently found in gatherings of *Sphagnum* from open moorland bogs during the summer months. It is a cosmopolitan species. It was found in a gathering from the Sikkim Himalaya, and it would appear from Leidy's observations ('Freshw. Rhiz. N. Amer.,' 1879) to be a common form on the American continent. That author figured it as a form of "*Difflugia globulosa*."

2. (?) **Phryganella nidulus** Penard

(Fig. 77.)

Difflugia globulosa Leidy (pars) Freshw. Rhiz. N. Amer. (1879), p. 96, t. xvi, ff. 1–6.

Phryganella nidulus Penard Faune Rhiz. Léman (1902), p. 419, ff. 1–4 (p. 420); and in Rev. Suisse Zool. XVI, 3 (1908), p. 449, t. xvii, ff. 1–3; Averintzev in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 361; Schouteden in Ann. Biol. Lacustre, I, 3 (1906), p. 360.

Test very large, heavily incrusted with sand-grains, and opaque; generally with a few larger quartz particles embedded in the crown or on the sides of the test; the mouth concentric in dorsal view; the outline of the test, when viewed laterally, hemispherical. Plasma colourless; the pseudopodia very similar to those of *P. acropodia*, from broad lobate expansions of ectoplasm, to narrow, digitate, more or less pointed ones, extending radially in all directions.

Dimensions: Average diameter 180–190 μ (*Penard*).

If large empty tests of the *globulus* type may be assumed to be those of *Phryganella nidulus* Penard, we may claim this, from examples met with in *Sphagnum*-bogs in England, Wales, and Scotland, to be a British species. But, for the reason already given, without an examination of the living organism—which is rarely met with—it is impossible to pronounce with certainty. Tests from near Ingleton, West Yorkshire, from various localities in Cheshire, and from North Wales answer to Penard's description and figures in 'Faune Rhiz. Léman.'

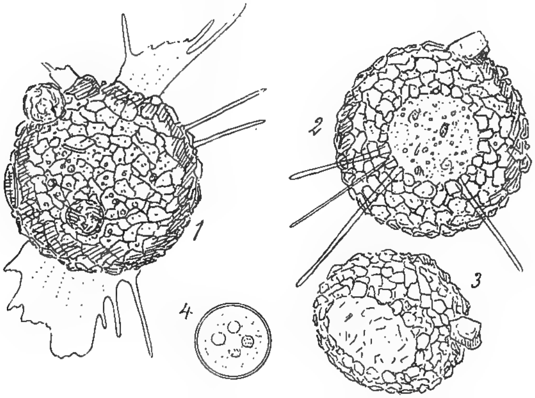


Fig. 77.—*Phryganella nidulus.* After Penard, *loc. cit.* (slightly reduced). 1, upper view; 2, oral view; 3, three-quarter view; 4, one of the nuclei. × about 140; the nucleus much more highly.

3. **Phryganella paradoxa** Penard.

(Plate XX, figs. 15 and 16.)

Phryganella paradoxa Penard Faune Rhiz. Léman (1902), p. 423, ff. 1–6; Averintzev in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 262; Schouteden in Ann. Biol. Lacustre, I, 3 (1906), p. 360.

Test thin, ovoid, truncated inferiorly; semi-transparent, the crown arched, with few extraneous particles adhering; not compressed; the mouth irregularly roundish; the pseudopodia radiating, thin, simple or bifurcated near the more or less pointed extremities. Nucleus single.

Dimensions: Length 30–40 μ; breadth about 28 μ.

In wet moss from the sluice-wall of an old mill at Baguley, Cheshire.

This species of *Phryganella* differs in the form of its test from *P. acropodia*, being more of the *Difflugia* type, whilst thin in structure and semi-transparent. The pseudopodia are long and thin. Our Cheshire examples correspond closely with Penard's description, but the pseudopodia, in the few examples met with, were simple, not bifurcate.

Genus 22. **DIFFLUGIELLA** Cash, 1904.

Difflugiella CASH in Jrn. Linn. Soc., Zool. XXIX (1904), p. 224.

Test ovoid in lateral view, not compressed, composed of chitinous transparent membrane, which is flexible (more so in the region of the mouth); protoplasm colourless, granular, nearly filling the cavity, slightly tinged with green from the inception of chlorophyllous food; the pseudopodia of two kinds, one lobular or digitate, protruding centrally from the mouth of the test, and terminated by a short acute apiculus, the other longer, straight, thin, tapering to a point, and projected laterally from each side.

This genus was with some hesitation proposed for a minute rhizopod which could not be satisfactorily referred to any previously existing one. It is distinguished from *Difflugia* by the peculiar apiculate pseudopodia, and by the extremely thin chitinous test, which has no incrustation of any kind.

1. **Difflugiella apiculata** Cash.

(Plate XX, figs. 17 and 18.)

Difflugiella apiculata CASH in Jrn. Linn. Soc., Zool. XXIX (1904), p. 225, t. xxvi, f. 7; AVERINTZEV in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 259; SCHOUTEDEN in Ann. Biol. Lacustre, I, 3 (1906), p. 359, f. 60.

Characters those of the genus. The test apparently little more than a chitinous film, flexible in the lower part. The plasma, as a rule, filled with fine granules and chlorophyllous material, with two or three vacuoles, and an inconspicuous nucleus. The cavity of the test more than three-fourths occupied. The abnormal character of the pseudopodia, when the organism is active, at once arrests attention.

Dimensions: Length about 40 μ; breadth 28 μ.

Amongst floating *Confervæ* and other vegetation in a broad and shallow stream crossed by the Barking and Purfleet road, about a mile from the town of Barking, May, 1901.

The permanence of the pseudopodal character seems to admit of no doubt, as a number of individuals, carefully examined, exhibited it clearly. The apiculate pseudopodia were generally very mobile, whilst the more elongated lateral ones were rigid, and showed little disposition to alter.

Genus 23. **CRYPTODIFFLUGIA** Penard, 1890.

Cryptodifflugia PENARD in Mém. Soc. Genève, XXXI (1890), 2, p. 168 (generic *name*); Faune Rhiz. Léman (1902), p. 425 (the genus described).

Minute, *Difflugia*-like organisms, with a chitinous (generally yellowish or brownish) compressed and smooth test, which has in most cases some investment of foreign particles; the granular plasma not filling the entire cavity, and the pseudopodia—which are long and acutely pointed—more numerous and less ramifying than in *Phryganella*.

Penard describes three species of *Cryptodifflugia*, all very minute, and differing from one another in the form of the test and degree of compression, whilst agreeing in the yellowish or golden-brown colour of the chitinous material of which the test is composed.

1. **Cryptodifflugia oviformis** Penard.

(Fig. 78.)

Cryptodifflugia oviformis PENARD in Mém. Soc. Genève, XXXI (1890), 2, p. 168, t. vii, ff. 95–107; and Faune Rhiz. Léman (1902), p. 425, ff. 1–4 (p. 426).

Test ovoid in broad view, minute, compressed, consisting of chitinous membrane, yellowish (becoming brown with age), with few or no foreign particles adhering; narrowed evenly from the semi-circular crown downwards to the small, truncated (in face view oval) mouth, the corners of which are obtusely angular. Plasma granular, with an inconspicuous nucleus situated posteriorly, and a varying quantity of minute chlorophyllous food-particles, and clear vacuoles.

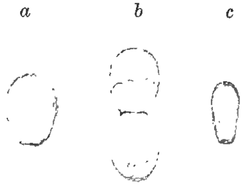


FIG. 78.—*Cryptodifflugia oviformis*. From Cader Idris, N. Wales. *a*, broad view; *b*, two individuals in conjugation; *c*, narrow view. × 480.

Dimensions: Length 16–20 μ; breadth 12–15 μ; in narrow view 8 μ.

In marshy ground amongst *Sphagnum*; slopes of Cader Idris, August, 1903.

This is one of the smallest of the Difflugian rhizopods. Examples met with in Wales were slightly broader proportionately than those represented in Penard's figures ('Faune Rhiz. Léman,' p. 426, ff. 1, 2), but they correspond with his description as to colour, dimensions, and general structure. In none of the individuals examined were pseudopodia visible; this also agrees with Penard's observation as to the shyness of the animal, and the infrequency of its display of pseudopodal activity. When the plasma was pent up within the test it filled the cavity, or nearly so. Empty tests showed the colour very clearly. It was generally a lightish yellow, not unlike that observed in *Ditrema*, passing (presumably with age) into a brownish tint resembling that of some diatoms. The test is strongly compressed, much narrowed anteriorly in the lateral view; the margins are nearly straight. Two individuals were found in conjugation. One test had absorbed most of the plasma of the other, leaving it more than half emptied. The nucleus was indistinguishable with a power of 480.

§ C. *Nebelina*.

Genus 24. **HYALOSPHENIA** Stein, 1857.

Hyalosphenia Stein in Sitzber. böhm. Akad. Wiss. 1857, p. 42.

Test homogeneous, of varying outline, in lateral view ovoid lengthways with sharply truncated mouth, or pyriform with the mouth convex; membranous, hyaline; compressed in all except one species; the crown uniformly arched. Plasma only partially filling the test, and attached to it by threads or bands of ectoplasm; containing chlorophyllous particles in varying quantity, usually one or two clear vacuoles, and a nucleus (comparatively large) situated posteriorly, but frequently obscured by food and other granular material. Pseudopodia three to five, simple, digitate, blunt.

The genus is distinguished from *Nebela* by the homogeneous test. In two or three species the surface is pitted, but the siliceous or other scales of more or less definite outline, which characterize the next genus, are altogether wanting.

1. **Hyalosphenia papilio** Leidy.

(Plate XXIV, figs. 1–4; and fig. 79 in text.)

Difflugia (*Catharia*) *papilio* LEIDY in Pr. Acad. Philad. 1874, p. 156.

Hyalosphenia papilio LEIDY in Pr. Acad. Philad. 1875, p. 415; *op. cit.* 1876, p. 197; and Freshw. Rhiz. N. Amer. (1879), p. 131, t. xxi; HITCHCOCK Synops. Freshw. Rhiz. (1881), p. 18; ENTZ in Biol. Centralbl. II (1882), p. 451; TARÁNEK in Sitzber. böhm. Ges. Wiss. 1881 (1882), p. 229; BLOCHMANN Mikr. Thierw. Süsswass. (1886), p. 12; and ed. 2 (1895), p. 15, t. i, f. 13; F. B. CARTER in Amer. M. Micr. Jrn. IX (1888), p. 10; HARVEY in Amer. Natur. XXII (1888), p. 72; PENARD in Mém. Soc. Genève, XXXI (1890), 2, p. 165, t. vii, ff. 23–35; in Jahrb. nassau. Ver. Naturk. XLIII (1890), p. 71; Faune Rhiz. Léman (1902), p. 337, ff. 1–5; and in Pr. R. Soc. Edinb. XXV, 8 (1905), p. 594; GRUBER in Zacharias' Tierw. Süsswass. (1891), I, p. 139, f. 16 (6); RHUMBLER in Zeits. wiss. Zool. LII, 4 (1891), p. 518; CASH in Tr. Manch. Micr. Soc. 1891 (1892), p. 49, t. ii, f. 9; LORD in Tr. Manch. Micr. Soc. 1891 (1892), p. 56; LEVANDER in Acta Soc. Fauna Fenn. XII (1894), 2, p. 20; *op. cit.* XVIII (1900), 6, p. 72 etc.; and XX (1901), 8, p. 8; SCHAUDINN in Deutsch-Ost-Africa, IV, 2 (1897), 19, p. 8; DADAY in Termész. Füzetek, XXI (1898), Suppl. pp. 5, 9; AVERINTZEV in Trudui S.-Peterb. Obshch. XXX, 1 (1900), p. 239; *op. cit.* XXXVI (1906), 2, p. 228; in Ber. Süsswass. Nat. Ges. St. Petersb. I (1901), p. 211; and in Protok. S.-Peterb. Obshch. XXXI, 7 (1901), p. 323; EYFERTH Naturgesch. mikr. Süsswass. ed. 3 (1900), p. 261; LAGERHEIM in Förh. Geol. Fören. Stockholm, XXIII (1901), p. 514 etc.; SCHOUTEDEN in Ann. Biol. Lacustre, I, 3 (1906), p. 352; LANDACRE in Pr. Ohio Acad. Sci. IV, 10 (1908), p. 428.

Test chitinous, transparent, yellowish, plain or with extremely delicate surface-markings or punctulations (visible only under a high power); in broad view oblong-oval or pyriform, the crown forming a semicircle with a minute pore on each side at the broadest part, or sometimes with one also in the centre of the crown; the sides converging gradually in straight lines from the crown downwards to the slightly-convex mouth. In narrow lateral view elongate-pyriform, the mouth forming a shallow notch; in dorsal or transverse view narrowly elliptic. The plasma often crowded with bright green chlorophyllous particles, with oil-like globules large and small, and much granular matter; attached to the interior of the test at the sides and on the crown with threads or bands of ectoplasm. The nucleus large, its position usually indicated by a pale space in the upper part of the body, but obscured more or less by the contents of the plasma; one or more vacuoles usually visible in the anterior region. Pseudopodia digitate, colourless, from two to six, simple, blunt.

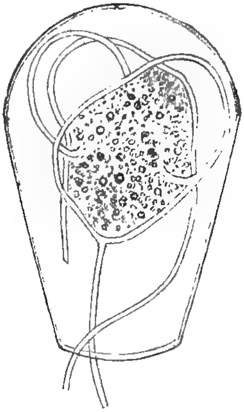


FIG. 79.—*Hyalosphenia papilio*. × about 350.

Dimensions: Length 110–140 μ.

In swampy places amongst *Sphagnum*; Knutsford Moor, Cheshire, associated with *H. elegans* Leidy, and other species. On the moors about Whitworth and Rawtenstall, Lancashire (*J. E. Lord*). Abundant in the Capel Curig district, N. Wales (*J. Hopkinson*). Pentland Hills and Midlothian, Scotland (*W. Evans*).

Hyalosphenia papilio, in common with nearly all the members of the genus, is most abundant in subalpine bogs. It is a beautiful form. Leidy says that, in giving the species the name it bears, he "associated it with the idea of a butterfly hovering among flowers." Its fairy-like movements, under the microscope, quite justify the appellation.

2. **Hyalosphenia cuneata** Stein.

(Plate XXXI, figs. 1–4; and fig. 80 in text.)

Hyalosphenia cuneata Stein in Sitzber. böhm. Akad. Wiss. X (1857), p. 42; Leidy Freshw. Rhiz. N. Amer. (1879), p. 129, t. xx, ff. 1–10; Hitchcock Synops. Freshw. Rhiz. (1881), p. 17; Taránek in Sitzber. böhm. Akad. Wiss. 1881 (1882), p. 229; Blanc in Bull. Soc. Vaudois, (2) XX (1885), p. 288; Forel Faune Lacs Suisse (1885), p. 131; and Le Léman (1904), III, pp. 136, 138; Certes Prot. in Mission scient. Cap. Horn, VI, 3 (1889), p. 20; Penard in Arch. Sci. nat. (4) VII (1899), p. 257 etc.; in Rev. Suisse Zool. VII, 1 (1899), p. 46, t. iv, ff. 17–19; Faune Rhiz. Léman (1902), p. 333, ff. 1–7; and Sarc. grands Lacs (1905), p. 37, 2 ff. (p. 38); Eyferth Naturgesch. mikr. Süsswass. ed. 3 (1900), t. ix, f. 11; G. S. West in Jrn. Linn. Soc., Zool. XXVIII (1901), p. 325; Zykoff in Bull. Soc. Nat. Moscou, XVII (1903), p. 15; Averintzev in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 229; Schouteden in Ann. Biol. Lacustre, I, 3 (1906), pp. 351, 352, f. 24; Hoogenraad in Tÿdschr. Nederl. Dierk. Ver. (2) X, 4 (1908), p. 408.

Arcella oblonga Lachmann in Verh. nat. Ver. Rheinl. XVI (1859), p. 60.

Difflugia ligata Tatem in M. Micr. Jrn. IV (1870), p. 313, t. lxviii, f. 1.

Catharia ligata Leidy in Pr. Acad. Philad. 1874, p. 79; and *op. cit.* 1875, p. 415.

Hyalosphenia lata F. E. Schulze in Arch. mikr. Anat. XI, 2 (1875), p. 335, t. xviii, ff. 15–18; Leidy in Proc. Acad. Philad. 1875, p. 415; Archer in Q. Jrn. Micr. Sci. (n.s.) XVII (1877), p. 110, t. viii, f. 5; and in Jrn. Dublin Micr. Club, III, 2 (1877), p. 228, t. viii, f. 5; Bütschli in Bronn's Thier-Reichs, I, 1 (1880), t. ii, f. 10; Averintzev in Trudui S.-Peterb. Obshch. XXX, 1 (1900), p. 229; and

Ber. Süsswass. nat. Ges. St. Petersb. I (1901), p. 211; LANG Lehrb. vergl. Anat., ed. 2, Prot. (1901), f. 3 B (p. 7); HARTOG Prot. in Cambr. Nat. Hist. I (1906), f. 10 B (p. 55).

Test shorter and broader than that of the preceding species, tapering from the convex or semi-circular crown evenly downwards to the truncated mouth; compressed round the margin (more than in the central portion), and composed of chitinous membrane, colourless and transparent. Plasma, as in the preceding, attached to the interior of the test by thread-like prolongations of its own substance. Pseudopodia few in number, in general character digitate, not branched. Nucleus as in the preceding species.

Dimensions: Length 75 μ; breadth 60 μ.

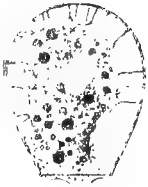


FIG. 80.—A variety of *Hyalosphenia cuneata.* Cocket Moss, Giggleswick, W. Yorks. × 310. From a drawing by G. S. West.

In *Sphagnum*; reported by Prof. G. S. West from Giggleswick, West Yorkshire; and also from the North of Ireland. Loch Ness, Scotland (*J. Murray*).

This is a rare species. It differs from *H. papilio* in the marginal compression of the test (the margin being obtuse), in its broader crown, and in the absence of lateral pores.

3. **Hyalosphenia inconspicua** G. S. West.

(Plate XXXI, figs. 5 and 6.)

Hyalosphenia inconspicua G. S. WEST in Jrn. Linn. Soc., Zool. XXIX (1903), p. 115, t. xiii, ff. 7–11; AVERINTZEV in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 228; SCHOUTEDEN in Ann. Biol. Lacustre, I, 3 (1906), p. 352.

Very minute; test very thin, of a reddish-brown colour, in front view with an almost circular outline, the basal portion being slightly protracted to form a short neck, the mouth small and truncate; in side view ovate-elliptical in form, with a notched mouth. Plasm occupying only about half the cavity of the shell, with a small nucleus and one short pseudopodium; contractile vacuoles not observed.

Dimensions: Length 14·5–17 μ; breadth 12·5–16 μ; breadth of mouth 6·5–7·7 μ.

Lough Gartan, Co. Donegal, Ireland (*West*).

This minute *Hyalosphenia*, the author (whose description we quote) says, is considerably smaller than any other known species. It was observed in quantity from the above-mentioned locality in May, 1901. The almost circular outline of the shell, and its reddish-brown colour, are characteristic. The animals were very sluggish and only protruded one small pseudopodium.

4. **Hyalosphenia minuta** Cash.

(Plate XXIV, figs. 5–11.)

Hyalosphenia minuta CASH in Tr. Manch. Micr. Soc. 1891 (1892), p. 49, t. ii, ff. 3, 4; AVERINTZEV in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 230; SCHOUTEDEN in Ann. Biol. Lacustre, I, 3 (1906), pp. 351, 352.

Test small, pellucid, composed of thin chitinous membrane; in front view ovoid, from the arched crown tapering evenly to the truncated mouth, which is rounded at the corners; strongly compressed; the mouth, in narrow lateral view, forming a slight notch. Plasma colourless, attached to the test usually by six or eight attenuated filaments; nucleus distinct, normally situated; the pseudopodia varying in number and form, sometimes represented by a single lobe, which is lingulate and nearly as long as the test, extending outwards, and (when the test is lying on its side) used *Amœba*-like as a means of locomotion.

When the test is erected, which is the normal attitude during activity in testaceous rhizopods, two to four blunt digitate pseudopodia are deployed, and the movements of the organism are normal.

Dimensions: Length 35–40 μ; breadth 20–25 μ.

In bogs, amongst *Sphagnum*; also in moss growing on moist rocks, rare. Dunham, Cheshire; and Perwick Bay, Isle of Man; August, 1891. Marsh near Sutton Broad, Norfolk; October, 1908 (*E. Gurney*).

The test of this interesting species is hyaline and colourless. At the mouth the texture is extremely thin; the lips shade off to the finest possible edge. The walls of the test being very transparent, the plasma is seen to contain, amongst a varying amount of granular material, minute chlorophyllous pellets, with some colourless particles intermixed.

The movements of the organism when lying on its broad side are unusual amongst testaceous rhizopods. Instead of erecting the test and throwing out digitate pseudopodia, it very frequently emits a lingulate mass of ectoplasm, which undergoes changes and exhibits forms closely resembling those of *Amœba limax* when in a state of activity. This peculiarity was very well marked in examples from Norfolk, found in *Sphagnum* collected by Mr. Edward Gurney. The tongue-like single pseudopodium became, at times, lobed, and even bifurcated at the apex, the lobes and short stumpy branches quickly coalescing and getting absorbed in the principal mass. The movements of the individual, effected in this way, were rapid though somewhat erratic. The peculiarity, being so distinctly exhibited by examples from widely-separated localities, may be taken as characteristic of the species.

5. **Hyalosphenia platystoma** G. S. West.

(Plate XXXI, figs. 7 and 8.)

Hyalosphenia platystoma G. S. West in Jrn. Linn. Soc., Zool. XXIX (1903), p. 114, t. xiii, ff. 3–6; Averintzev in

Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 230; SCHROUTEDEN in Ann. Biol. Lacustre, I, 3 (1906), p. 352.

Rather larger than the preceding species; test consisting of a colourless transparent chitinoid membrane; ovoid in front view with a semi-circular apex and a widely-truncate base; the sides slightly convex and the mouth very wide; in side view narrowly ovoid, with no trace of a constriction towards the apex, slightly notched at the mouth. Protoplasmic body held in position by several fine strands passing to the inner surface of the test; inferior part clear; the superior part granular and filled with food-particles; nucleus dorsal and prominent; contractile vacuoles not observed; pseudopodia two, short and lobose.

Dimensions: Length 40–42 μ; breadth 28–32 μ.

Near Tarbert, Harris, Outer Hebrides (*West*).

Prof. G. S. West (whose description we quote) says: "Numerous active specimens of the above species were observed in a collection from a *Sphagnum*-bog. The small size of the shell and the extremely broad mouth are features which easily distinguish it. In the side view there is no trace of a constriction towards the apex of the shell, and there is a distinct line of demarcation between the lower part of the body-protoplasm, which gives origin to the pseudopodia, and the upper granular portion." The author points out that as compared with *H. minuta* the form of the shell is different, the mouth being much broader and more truncate; and the body-protoplasm and pseudopodia exhibiting rather different characters.

6. **Hyalosphenia subflava** *sp. nov.*

(Plate XXXI, figs. 9–12.)

Test resembling, in general form, that of *H. minuta*, but larger, and differing from it also in being of more substantial-looking texture; chitinous, compressed;

ovoid in broad view, the crown arched, with a minute pore on its apex; the sides tapering convexly downwards to the base where the mouth is visible in outline. Laterally the test is narrowly elliptic, but the sides, unlike those of *H. minuta* which taper almost to a point, are uniformly convex, and the mouth appears as a shallow notch, clearly outlined. The mouth, when directed upwards to the eye, is seen to be small in proportion to the size of the test, and elliptic. Colour of the test yellowish.

Dimensions: Length 65–70 μ; breadth 45–50 μ; in narrow lateral view 25–26 μ.

First met with in boggy parts of Irlam Moss, near Manchester, 1891—empty tests for the most part. Also found in *Sphagnum* gathered in the Pentlands, Midlothian, by Mr. W. Evans; June, 1905.

Examples from the widely-separated localities mentioned evidently belonged to the same species, although they presented differences, possibly to be accounted for by difference of environment. It should be stated that in the Lancashire locality only one or two living examples were met with, and those not exhibiting pseudopodia. The plasma was crowded with food-particles, and for that reason, perhaps, the animals were at the time dormant. Empty tests were distinctly homogeneous, yellowish-coloured, and destitute of surface-markings.

Examples from the Pentlands had the same general features, but the test was broader at the crown, and the sides converged, in nearly straight lines, to the base, the mouth also being smaller, forming an oval slit. Owing to this peculiarity the test, viewed laterally—that is, with the narrow margin to the eye—presented an almost unbroken elliptic outline, as, with an aperture so small, the notch was hardly perceptible. The Pentland examples, moreover, varied amongst themselves, some being, as above stated, broader at the crown than below, whilst others were more distinctly ovoid, approximating in form to the Lancashire specimens. In no case were the corners, at the mouth, sharply angled.

7. **Hyalosphenia elegans** Leidy.

(Plate XXIV, figs. 12–14; Plate XXXI, figs. 13 and 14; and figs. 81 and 82 in text.)

Difflugia (*Catharia*) *elegans* LEIDY in Pr. Acad. Philad. 1874, p. 156; and *op. cit.* 1875, p. 415.

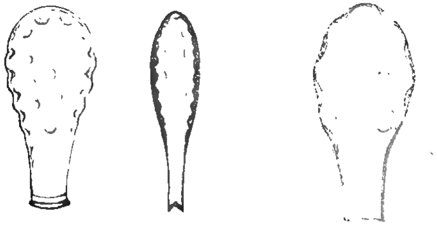
Hyalosphenia elegans LEIDY in Pr. Acad. Philad. 1875, p. 415; *op. cit.* 1879, p. 163; and Freshw. Rhiz. N. Amer. (1879), p. 140, t. xx, ff. 19–29; HITCHCOCK Synops. Freshw. Rhiz. (1881), p. 19; TARÁNEK in Sitzber. böhm. Akad. Wiss. 1881 (1882), p. 229; BLOCHMANN Mikr. Thierw. Süsswass. (1886), p. 12; and ed. 2 (1895), p. 15; GREEFF in Sitzber. Ges. Nat. Marburg, 1888, 3, p. 112; HARVEY in Amer. Natur. XXII (1888), p. 73; PENARD in Mém. Soc. Genève, XXXI (1890), 2, p. 165, t. vii, ff. 36–39; and Faune Rhiz. Léman (1902), p. 339, ff. 1–3 (p. 340); PERRY in Pr. Amer. Soc. Micr. XII (1891), p. 95; ENTZ in Res. wiss. Erforsh. Balatons. (1897), II, 1, p. xxiv; DADAY in Termész. Füzetek, XXI (1898), Suppl. pp. 5, 9; CASH in Tr. Manch. Micr. Soc. 1891 (1892), p. 49, t. ii, ff. 10, 11; AVERINTZEV in Trudui S.-Peterb. Obshch. XXX, 1 (1900), p. 239; *op. cit.* XXXVI (1906), 2, p. 227; and in Ber. Süsswass. Nat. Ges. St. Petersb. I (1901), p. 211; LAGERHEIM in Förh. Geol. Fören. Stockholm, XXIII (1901), p. 514; LEVANDER in Acta Soc. Fauna Fenn. XVIII (1900), 6, p. 77 etc.; and *op. cit.* XX (1901), 8, p. 9; G. S. WEST in Jrn. Linn. Soc., Zool. XXVIII (1901), p. 325; and in Ann. Scott. Nat. Hist. 1905, p. 90; SCHOUTEDEN in Ann. Biol. Lacustre, I, 3 (1906), pp. 351, 352, f. 23; HOOGENRAAD in Tÿdschr. Nederl. Dierk. Ver. (2) X (1908), p. 409.

Hyalosphenia turfacea TARÁNEK ? in Sitzber. böhm. Ges. Wiss. 1881 (1882), p. 229.

Test of colourless or pale-yellowish chitinous membrane; in broad view flask-shaped, ovoid, or pyriform with a cylindroid neck, slightly convex at the mouth; in lateral view narrowly elliptic, the sides tapering downwards to the mouth, which is deeply notched. Elliptic in transverse section. Surface of the test pitted with hemispherical indentations which give the margin a more or less wavy outline, and are carried over the broader surface obliquely at regular distances. Protoplasm as in *H. papilio*, the nucleus normally situated, usually distinct; pseudopodia few, simple.

Dimensions: Length 75–100 μ; breadth of body 60 μ; at mouth 25–30 μ.

In bogs amongst *Sphagnum* and other mosses. Knutsford Moor, Cheshire; Sychnant Pass, Carnarvonshire. West Yorkshire (*G. S. West*). Capel Curig, N. Wales, frequent (*J. Hopkinson*). Aberfoyle and elsewhere in Scotland (*W. Evans*). Loch Ness, Scotland (*J. Murray*).



FIGS. 81 AND 82.—*Hyalosphenia elegans:* 81, from Knutsford Bog, Cheshire, × 280; 82 (drawn by G. S. West), from Cocket Moss, W. Yorks, × 300.

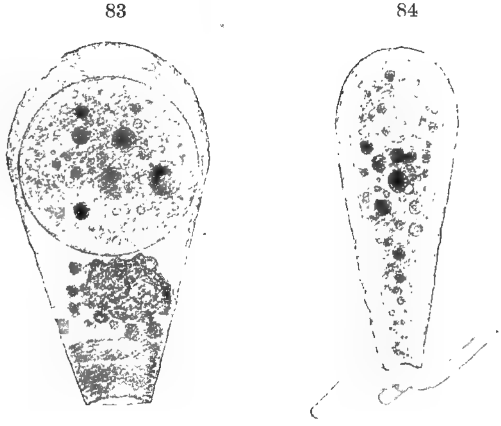
H. elegans is a distinct and easily recognized species, different in the character of the neck and the pitted test from any of its allies. The transparency and graceful outline of the test makes it a beautiful object under the microscope. It becomes yellowish, turning to pale brown with age.

Examples gathered in North Wales had a more even outline, whilst the hemispherical pits covering the broad surface of the test were fewer than in those from Cheshire (fig. 81), which were the most perfect we have seen. In lateral view, however, there was little difference to be seen.

8. **Hyalosphenia sinuosa** *sp. nov.*

(Plate XXIV, figs. 1 and 2; and figs. 83 and 84 in text.)

Test in front view elongated-pyriform, compressed; its crown semi-circular, with the sides tapering, each with a crenulate outline, downwards to the truncated mouth. The entire surface pitted with circular depressions; hyaline, colourless; the mouth, in narrow lateral view, forming a shallow notch. Plasma, seen through the transparent membranous envelope, not filling the cavity, but reaching very nearly to the fundus, in which region the nucleus—visible as a circular pale space—is situated; pseudopodia numerous, bifurated or simple.



Figs. 83 and 84.—*Hyalosphenia sinuosa*: 83, broad view of an encysted individual; 84, narrow view of an active individual. From Dunham, Cheshire. × 220.

Dimensions: Length 200–236 μ; breadth 110–125 μ; average breadth in narrow lateral view 65 μ.

Found in tufts of *Philonotis fontana*, Dunham; May and September, 1891.

This exceedingly fine species is not common. It is readily distinguished by its pitted test, the pits being normally circular, though sometimes, from being closely crowded, sub-hexagonal, the interspaces forming elevated ridges which make the surface rugose. The test is very transparent. The animal is graceful in its movements, but very timid.

9. **Hyalosphenia nobilis** *sp. nov.*

(Plate XXV, figs, 1–3.)

Test of translucent chitinous membrane, flask-shaped, the body in side view forming a perfect ellipse, with a long cylindrical neck truncated at the mouth, which is circular in outline and faintly undulated on the margin. In dorsal or transverse view the test is uniformly circular; its whole surface pitted with irregularly-formed depressions. The protoplasm generally filled with chlorophyllous pellets and oil-like globules; the nucleus conspicuous, situated in the posterior region. Pseudopodia four to six, simple, usually short and colourless.

Dimensions: Average length 200 μ; greatest width 90 μ; diameter at the mouth 30 μ.

Amongst aquatic mosses and other vegetation on Knutsford Moor, Cheshire; August, 1891.

This large and particularly elegant rhizopod occurred in considerable plenty amongst the rootlets of *Aulacomnium palustre.* It has a test of glassy transparency, perfectly colourless, with a rugose surface caused by the pits, and devoid of incrustation. The form of the test, so different from that of other *Hyalospheniæ* in exhibiting not the least indication of compression, first led us to class it with the *Difflugiæ*. The homogeneous test, however, notwithstanding the circular transverse section it presents, indicates a closer affinity with *Hyalosphenia,* and to that genus we have accordingly removed it.

Genus 25. **NEBELA** Leidy, 1874.

Difflugia (pars) Ehrenberg in Monatsb. Akad. Wiss. Berlin, 1848, p. 218.

Nebela Leidy in Pr. Acad. Philad. 1874, p. 156.

Test of thin chitinous material, usually very transparent, more or less compressed, ovate, pyriform, or elongate, in broad view, with a surfacing of circular or oval discs or plates, uniform or of mixed sizes, or of amorphous scales, with straight rods or rectangular plates interspersed without any appearance of regularity; plain-margined, or keeled, the carina being sharp-edged. The plasma ordinarily colourless, but more or less granular, the contents consisting of chlorophyllous food-pellets, large and small, with numerous refringent oil-globules, and one or more clear vacuoles. The nucleus—always single—situated in the upper region of the body. Bands of ectoplasm—sometimes bifid—or attenuated threads of ectoplasm, emanating chiefly from the posterior part of the body and forming attachments with the internal surface of the test. Pseudopodia variable in number, blunt, rarely bifid or branched.

1. **Nebela collaris** (Ehrenberg) Leidy.

(Plate XXV, figs. 4–7; and figs. 85 and 86 in text.)

Difflugia collaris Ehrenberg in Monatsb. Akad. Wiss. Berlin, 1848, p. 218; and in Abh. Akad. Wiss. Berlin, 1871 (1872), p. 143, t. ii, f. 27; Pritchard Hist. Infus. new ed. (1852), p. 208; and ed. 4 (1861), p. 553.

Difflugia reticulata Ehrenberg in Monatsb. Akad. Wiss. Berlin, 1848, p. 218; Mikrogeol. (1854), p. 331; and in Abh. Akad. Wiss. Berlin, 1871 (1872), p. 143, t. ii, f. 26.

Difflugia cancellata Ehrenberg in Monatsb. Akad. Wiss. Berlin, 1848, p. 379; Mikrogeol. (1854), p. 331; and in Abh. Akad. Wiss. Berlin, 1871 (1872), p. 145, t. ii, f. 3.

Difflugia carpio Ehrenberg Mikrogeol. (1854), p. 331; in Abh. Akad. Wiss. Berlin, 1871 (1872), p. 251, t. ii, ff. a, 27; b, 21.

Difflugia laxa Ehrenberg in Abh. Akad. Wiss. Berlin, 1871 (1872), p. 254, t. iii, f. 22.

Difflugia cellulifera EHRENBERG in Deutsche Nordpolarfahrt (1874), II, pp. 460, 466, Zool. 15, t. iii, f. 24.
Difflugia (*Nebela*) *numata* LEIDY in Pr. Acad. Philad. 1874, p. 157.
Nebela numata LEIDY in Pr. Acad. Philad. 1876, p. 116, ff. 1–5; and *op. cit.* 1877, p. 264.
Nebela collaris LEIDY (pars) in Proc. Acad. Philad. 1879, p. 162; *op. cit.* 1880, pp. 335, 336; and Freshw. Rhiz. N. Amer. (1879), p. 145, t. xxii, ff. 1–10, 13–15, 17–20; t. xxiv, f. 11; and f. (p. 151); HITCHCOCK Synops. Freshw. Rhiz. (1881), p. 21; TARÁNEK in Sitzber. böhm. Ges. Wiss. 1881 (1882), p. 230; and in Abh. böhm. Ges. Wiss. (6) XI (1882), 8, p. 32 etc., t. i, ff. 3–12; t. ii, ff. 1–3; t. iv, ff. 1–3; WALLICH in Ann. Nat. Hist. (5) XVI (1885), p. 472; BLOCHMANN Mikr. Thierw. Süsswass. (1886), p. 13, t. i, ff. 25, 25a; and ed. 2 (1895), p. 17, t. i, ff. 19, 19a; FIELDE in Proc. Acad. Philad. 1887, pp. 122, 123; BARROIS Mater. étude faune Açores, III (1888), p. 11; and in Mém. Soc. Sci. Lille (5) VI (1896), p. 108 etc.; GREEFF in Sitzber. Ges. Nat. Marburg, 1888, 3, p. 109; GUERNE Excurs. zool. Fayal et San Miguel (1888), p. 109; HARVEY in Amer. Natur. XXII (1888), p. 73; IMHOF in Zool. Anzeig. XI (1888), p. 565; SACCHI in Boll. scient. III, an. 10 (1888), p. 46; and in Jrn. Microg. XII (1888), p. 377; CERTES Prot. in Mission scient. Cap. Horn, VI, 3 (1889), pp. 11, 13, t. ii, ff. 2–5; PENARD in Jahrb. nassau. Ver. Naturk. XLIII (1890), p. 71; in Mém. Soc. Genève, XXXI (1890), 2, p. 157, t. vi, ff. 21–44; in Amer. Natur. XXV (1891), pp. 1071, 1073; Faune Rhiz. Léman (1902), p. 347, ff. 1–7; in Arch. Protist. II (1903), p. 258; in Pr. R. Soc. Edinb. XXV, 8 (1905), p. 594 etc.; and in Jrn. R. Micr. Soc. 1907, p. 278; LORD in Sci. Goss. XXVIII (1891), p. 228, ff. 190–194; and in Tr. Manch. Micr. Soc. 1891 (1892), p. 56; CASH in Tr. Manch. Micr. Soc. 1891 (1892), p. 50, t. ii, f. 24; SCHEWIAKOFF in Mém. Acad. Sci. St. Pétersb. (7) XLI (1893), 8, p. 98; LEVANDER in Acta Soc. Fauna Fenn. XII (1894), 2, p. 19; and *op. cit.* XX (1901), 8, p. 8 etc.; FRANCÉ Prot. in Result. Erforsch. Balatons. II, 1, (1897), p. 8; FRENZEL in Bibl. Zool. IV, 12 (1897), p. 148; FUHRMANN in Rev. Suisse Zool. IV (1897), p. 504 etc.; SCHAUDINN in Deutsch-Ost-Africa, IV, 2 (1897), 19, p. 10; SCOURFIELD in Pr. Zool. Soc. 1897, p. 787; ANDRÉ in Jahresb. nat. Ges. Graubünd. XLI (1898), p. 57 etc.; PROWAZEK in Zool. Anzeig. XXII (1899), p. 344; in Arb. zool. Inst. Wien, XII, 3 (1900),

p. 247, t. i, f. 3; and in Zeits. angew. Mikr. V, 10 (1900), p. 271; AVERINTZEV (pars) in Trudui S.-Peterb. Obshch. XXXI, 1 (1900), p. 240; *op. cit.* XXXVI (1906), 2, p. 250; and in Ber. Süsswass. nat. Ges. St. Petersb. I (1901), p. 215; EYFERTH Naturgesch. mikr. Süsswass. ed. 3 (1900), p. 264; GODET ? in Bull. Soc. Neuchâtel, XXVIII (1900), p. 77; LAGERHEIM in Förh. Geol. Fören. Stockholm, XXIII (1901), p. 515; G. S. WEST in Jrn. Linn. Soc., Zool. XXVIII (1901), p. 321; and in Ann. Soc. Nat. Hist. 1905, pp. 90, 92; MURRAY in Pr. R. Soc. Edinb. XXV, 8 (1905), p. 614; and in Ann. Scott. Nat. Hist. 1907, p. 95; CUSHMANN in Amer. Natur. XL (1906), p. 373; SCHORLER & THALLWITZ in Ann. Biol. Lacustre, I, 2 (1906), p. 260; SCHOUTEDEN (pars) in Ann. Biol. Lacustre, I, 3 (1906), pp. 354, 356, f. 27; LANDACRE in Pr. Ohio Acad. Sci. IV, 10 (1908), p. 429.

Test in broad view pyriform, longer than the width, variable within certain limits; the crown broadly convex, the sides sloping evenly downwards, straight or with little convexity, to the slightly-convex or truncate mouth. In narrow lateral view oblong, the crown obtuse, the mouth without any notch. Substance of the test colourless, and structurally variable, with a surfacing of discs (circular or oval) generally uniform but not infrequently mixed large and small, with rods and square plates, not overlapping but laid edgewise, diaphanous, and producing an ornamental groundwork. The plasma colourless, always containing chlorophyllous food-particles; nucleus normal; pseudopodia digitate, knotted or simple, short, three to six in number.

Dimensions: Length about 130 μ; breadth 86–90 μ.

In marshes amongst *Sphagnum*, widely distributed. In Cheshire, common; also about Criccieth, Towyn, and Tan-y-Bwlch, N. Wales. Moel Siabod and above Dolgam, Capel Curig, N. Wales; and Calary Bog, Co. Wicklow, Ireland (*J. Hopkinson*). Epping Forest, Essex; and Loch Ness, Scotland (*D. J. Scourfield*). Pentlands and Aberfoyle, Scotland (*W. Evans*). Orkney Islands and Hebrides (*G. S. West*).

Under the name of *N. collaris*, Leidy included several forms now recognized as distinct, but, so far as can be gathered from his description and figures, that here described must be regarded as typical of the species. It differs from *N. tincta* (Leidy), and *N. flabellulum* Leidy (its nearest allies) in having a test which is not suddenly contracted to form a short cylindrical neck; it is wider at the mouth than either of these; and almost invariably the sides, if not dilated, cease to converge just above the basal angles. The species is one of the commonest in sphagnous swamps. Being more elongated in proportion to its breadth than either *N. tincta* or *N. flabellulum*, and having its sides straight or only slightly convex, *N. collaris* may without difficulty be differentiated from the species here named. One not familiar with the nice distinctions between various allied forms would be more apt to confuse it with the more elongated *N. tubulosa* Penard, or *N. americana* Taránek. These however, as will be seen by a reference to the descriptions, have characters which sufficiently distinguish them.

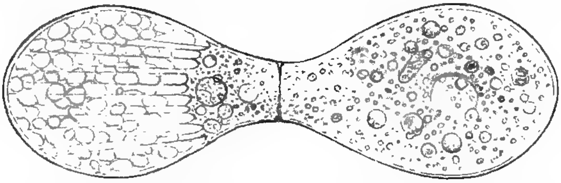


FIG. 85.—*Nebela collaris* in conjugation. Dunham, Cheshire. × 250.

Nebela collaris is the only rhizopod whose empty test we have seen taken possession of by a higher organism. Repeated instances occurred in one of Mr. Hopkinson's gatherings from Capel Curig [Moel Siabod] in the summer of 1908, of a species of rotifer* using it as a dwelling-place—whether adventitiously or by design was not apparent. The animals (usually only one in a test) were very active, protruding

* [Apparently a *Callidina*.]

their heads and displaying their cilia, and, when alarmed, retiring suddenly into the cavity. Whilst this took place the posterior part of the rotifer (it did not exhibit the usual tail-like process) remained stationary for a time; the anterior half would again slowly extend; and the ciliated processes would unfold but a short distance beyond the orifice of the test. The action of the maxillæ was distinctly visible through the transparent test-walls. The cilia were used for purposes of locomotion, and it was curious to see a test of *Nebela collaris* dragged about by the rotifer in its tortuous course through the water.

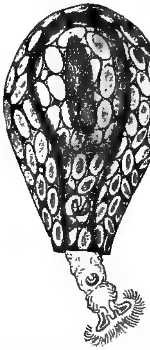


FIG. 86.—Test of *Nebela collaris* taken possession of by a rotifer. The maxillæ are seen $\frac{1}{5}$ in. (5 mm.) above the aperture of the test. (Re-drawn from a rough sketch by Mr. Cash.) × 280.

One example met with was interesting from the fact that the test of the *Nebela* contained not only a living rotifer—apparently young—but also, along with it, two ova. The mature rotifer was free, and appeared to make great efforts to escape from its prison, but this was impossible from the fact that the neck was choked with mucus, probably what remained of the rhizopod protoplasm; and the explanation which suggested itself was that the eggs of the rotifer had been deposited, and were being hatched out, in the cavity of the test. If that were so one is almost driven to the conclusion that they were parasitic. It is difficult to see how the eggs could have found their way through the narrow orifice of the test if they were "laid" by the parent rotifer in any external position.

Under the name of *Difflugia bipes*, Carter ('Ann. & Mag. Nat. Hist.,' Ser. 4, Vol. V) described a rhizopod which, from the figures given, appears to be a malformed example of *Nebela collaris.* If the test were perfect it would not be distinguishable from that species, but the crown, instead of forming a regular arch, is bulged in at the apex, producing a deep concavity, the cusps of which (as the test lies on its broad side) are convergent.

[As, however, it is possible that this may be a good species, Carter's description and three of his figures are here reproduced, his dimensions in fractions of an inch being converted into micromillimetres, and a small figure showing the circular scales slightly overlapping each other being omitted.

? **Nebela bipes** (Carter) Murray.

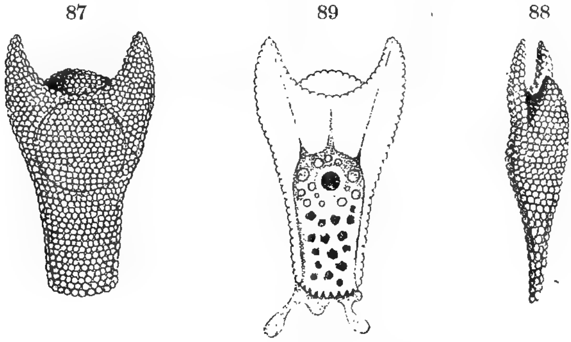
(Figs. 87–89.)

Difflugia bipes CARTER in Ann. Nat. Hist. (4) V (1870), p. 323, t. v, ff. 6–9; BÜTSCHLI in Bronn's Thier-Reichs, I, 1 (1880), t. iii, f. 10.

Nebela bipes MURRAY in Pr. R. Soc. Edinb. XXV, 8 (1905), p. 609.

Test oblong, somewhat compressed, expanded posteriorly, narrowed anteriorly; lateral view lageniform, with the body somewhat inflated; posterior extremity obtuse, convex, accompanied on each side by a cruriform conical extension of the test; anterior extremity narrow, terminating in a contracted oral orifice bordered by pointed scales, which, in a circular form, slightly overlapping each other, cover the whole of the test in great uniformity.

Animal composed of colourless granular sarcode, emitted anteriorly in obtuse pseudopodial prolongations for progression and the capture of food; ventral portion more or less charged with fragments of algæ and oil-globules; posterior extremity containing a large nucleus and nucleolus, several reproductive (?) cells, and one or more contractile vesicles. Body tied by three sarcodal fragments to the posterior part of the test and to the extremities of the hollow, conical, leg-like appendages respectively. Molestation causing the body to assume a spherical form, synchronously with which it is suddenly retracted by the sarcodal filaments to the posterior end of the test.



Figs. 87–89.—"*Difflugia bipes*" Carter: 87, broad view of test; 88, narrow view; 89, the living animal. The circle in fig. 87 shows the position of the animal when withdrawn into its test. × 250.

Dimensions: Length about 140 μ; breadth 72 μ (; width of aperture 35 μ).

Freshwater pool in heath-bog, living on minute algæ (*Oscillaria*, etc.), progressing after the manner of *Difflugiæ* generally, with the test vertical and the fundus uppermost; Budleigh-Salterton, Devon, 1869 (*H. J. Carter*). Also in Loch Ness, Scotland, 1903 or 1904 (*James Murray*).

Carter states that the colour of the test was light yellow, and that he found three or four specimens in the surface-pool of a heath-bog about a mile from Budleigh-Salterton. It would be strange if several individuals were similarly malformed, and if such malformation of *Nebela collaris* occurs in a deep lake in Scotland as well as in a shallow pool in Devonshire. Dr. Penard named the form dredged in Loch Ness *Nebela bipes* (Carter) from a drawing by Mr. Murray, and in a letter to the writer he says that in his opinion it is a good species, and that, "physically speaking, it would be rather difficult for a shell of *Nebela collaris* to take that form of malformation."]

2. **Nebela tincta** (Leidy) Averintzev.

(Plate XXV, figs. 8–11; and figs. 90, 91, and ? 92 in text.)

Difflugia proteiformis PERTY ? Kenntn. kleinst. Lebensf. (1852), p. 187, t. ix, f. 8.

Hyalosphenia tincta LEIDY (pars) Freshw. Rhiz. N. Amer. (1879), p. 138, t. xx, ff. 11–17; HITCHCOCK Synops. Freshw. Rhiz. (1881), p. 18; DE TARR in Rep. N. York State Mus. XXXV (1884), p. 166; CERTES Prot. in Mission Scient. Cap. Horn, VI, 3 (1889), p. 20; HARVEY in Amer. Natur. XXII (1888), p. 72; LORD in Tr. Manch. Micr. Soc. 1891 (1892), p. 55.

Nebela bursella TARÁNEK in Sitzber. böhm. Ges. Wiss. 1881 (1882), p. 230, f. 2 (p. 231); and in Abh. böhm. Ges. Wiss. (6) XI (1882), p. 36, t. iii, ff. 7–14; t. iv, f. 16; PENARD in Mém. Soc. Genève, XXXI (1890), 2, p. 163, t. vii, ff. 6–11; in Jahrb. nassau. Ver. Naturk. XLIII (1890), p. 71; Faune Rhiz. Léman (1902), p. 366, ff. 1–3; and in Pr. R. Soc. Edinb. XXV, 8 (1905), p. 594; BLOCHMANN Mikr. Thierw. Süsswass. (1886), p. 13, and ed. 2 (1895), p. 17; AVERINTZEV in Trudui S.-Peterb. Obshch. XXX, 1 (1900), p. 240; and in Ber. Süsswass. nat. Ges. St. Petersb. I (1901), p. 215; MURRAY in Ann. Scott. Nat. Hist. 1907, p. 95.

Nebela tincta AVERINTZEV in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 249; SCHOUTEDEN in Ann. Biol. Lacustre, I, 3 (1906), pp. 354, 356.

Test oval or sub-rotund, sometimes approaching to pyriform, much compressed, composed of transparent yellowish chitinous membrane, with a surfacing of oval or circular plates of variable size (which are in contact at the edges but never overlap), the inflated sides narrowing suddenly into a short neck; the mouth slightly arcuate, or oval when viewed transversely. Plasma not differing from that of the preceding species; the nucleus normally situated; pseudopodia three to six, simple, blunt, generally very mobile.

Dimensions: Length 85–90 μ; sometimes attaining 110 μ, or more.

In *Sphagnum*, abundant; also on the mossy sides of peat drains in turbaries amongst tufts of *Dicranella cerviculata*. Frequent in *Sphagnum* from Capel Curig (Moel Siabod, etc.), N. Wales; and Co. Wicklow, Ireland (*J. Hopkinson*). Loch Ness (*D. J. Scourfield*), and Midlothian (*W. Evans*), Scotland.

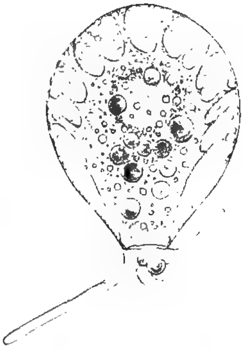


Fig. 90.—*Nebela tincta.* Chat Moss, Lancashire. × 300.

Leidy, probably misled by imperfect examples whose tests presented the appearance of "a pale yellow, transparent, structureless, chitinoid membrane," referred this organism to the genus *Hyalosphenia.* Typical British examples show a test which is very distinctly tesselated, with circular or oval plates (fig. 91) as in *Nebela collaris*, their edges in contact but not overlapping, whilst not infrequently, in addition to these plates and mingled with them, there are quadrangular plates, and rods (see fig. 92), all apparently of siliceous substance. It rarely happens that the plates are all circular, or all oval; more frequently they are mixed, without order or proportion, and their edges are well defined.

Examples are occasionally met with which approximate on the one side to *N. collaris* and on the other to *N. flabellulum*, but an acquaintance with the varied peculiarities of these species will usually dispel any difficulty which may be felt in differentiating them.

Individuals met with in places which are liable to get dried up are generally poor and misshapen.

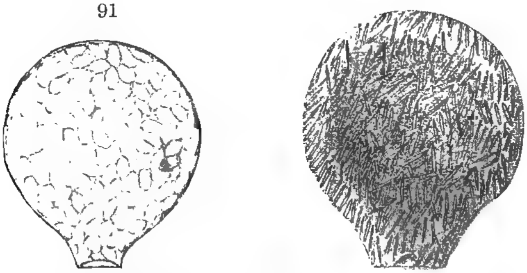


FIG. 91.—Test of *Nebela tincta*. Dunham, Cheshire. × 280.
FIG. 92.—"*Difflugia proteiformis*" Perty: ? = test of *Nebela tincta*. After Perty, *loc. cit.* × 300.

3. **Nebela lageniformis** Penard.

(Plate XXV, figs. 12–14.)

Nebela sp. LEIDY Freshw. Rhiz. N. Amer. (1879), p. 160, t. xxiv, ff. 18, 19.

Nebela lageniformis PENARD in Mém. Soc. Genève, XXXI (1890), 2, p. 158, t. vi, ff. 50–61; in Jahrb. nassau. Ver. Naturk. XLIII (1890), p. 71; Faune Rhiz. Léman (1902), p. 355, ff. 1–4 (p. 356); in Arch. Protist. II (1903), p. 259; in Pr. R. Soc. Edinb. XXV (1905), 8, pp. 594, 596; and in Jrn. R. Micr. Soc. 1907, p. 278; LEVANDER in Acta Soc. Fauna Fenn. XII (1894), 2, p. 20; and *op. cit.* XX (1901), 8, p. 9; SCHAUDINN in Deutsch-Ost-Africa, IV, 2 (1897), 19, p. 10; AVERINTZEV in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 246; and in Ann. Biol. Lacustre, II, 1 (1907), p. 166; SCHOUTEDEN in Ann. Biol.

Lacustre, I, 3 (1906), pp. 354, 355; MURRAY in Ann. Scott. Nat. Hist. 1907, p. 95.

Nebela ambigua CASH in Tr. Manch. Micr. Soc. 1891 (1892), p. 50, t. ii, f. 17.

Nebela collaris var. *lageniformis* G. S. WEST in Jrn. Linn. Soc., Zool. XXVIII (1901), p. 321.

Body of the test elliptic in broad view, compressed, with a prominent tubular neck which is swollen midway between its junction with the body and the oral extremity; the mouth convex or arcuate. In lateral view also elliptic, but one half narrower; the neck compressed, slightly convex on the lateral margins. Structure of the test very similar to that of the allied species, being of clear transparent substance and covered with circular discs, which adhere at their edges but do not overlap; sometimes polygonal scales form the surfacing, with a small proportion of longitudinal rods or plates intermingled. Plasma and pseudopodia not differing from those of other members of the genus; the nucleus normally situated, one or more contractile vacuoles frequently visible.

Dimensions: Length 120–125 μ; breadth of body 65–70 μ; of mouth about 20 μ.

In boggy ground, amongst *Sphagnum*, Dunham and Knutsford, Cheshire; more abundant in sub-alpine districts in Wales and Scotland as at Capel Curig and Llyn Idwal, in Carnarvonshire, and Towyn, Merionethshire. Near Sutton Broad, Norfolk (*E. Gurney*). Epping Forest, Essex (*D. J. Scourfield*). Penyghent, W. Yorks (*G. S. West*). Moel Siabod, N. Wales, at 2500 ft. (*J. Hopkinson*). Loch Ness, Scotland (*D. J. Scourfield*).

This species is very distinct; its neck, with the swollen margins, sufficiently differentiating it from other *Nebelæ*. It occurs very frequently in *Sphagnum* from the Welsh localities above named. But little variation can be noted in size or structure. Leidy was of opinion that this was an intermediate form connecting *N. collaris* with *N. barbata*, but we have sought in vain for any approach to either of those species. The former has not, in any of its variations, the tubular swollen neck of *N. lageniformis;* whilst *N. barbata* is very much smaller, and has a neck, with parallel margins, considerably narrower in proportion to its length. The species though stated by Penard to be rare on the continent is frequently met with in sub-alpine localities in this country.

4. **Nebela militaris** Penard.

(Plate XXV, figs. 15 and 16.)

Hyalosphenia tincta LEIDY (pars) Freshw. Rhiz. N. Amer. (1879), p. 138, t. xx, f. 18; LANDACRE in Pr. Ohio Acad. Sci. IV, 10 (1908), p. 428.

Nebela collaris LEIDY (pars) Freshw. Rhiz. N. Amer. (1879), p. 147, xxiii, f. 7; G. S. WEST (pars) in Jrn. Linn. Soc., Zool. XXVIII (1901), p. 321.

Nebela bursella VEJDOVSKÝ (pars) Thier. Org. Brünn. Prag. (1882) t. ii, f. 2; TARÁNEK (pars) in Sitzber. böhm. Ges. Wiss. 1881 (1882), p. 230, f. 2; and in Abh. böhm. Ges. Wiss. (6) XI (1882), 8, p. 36, t. iii, ff. 7–14.

Nebela militaris PENARD in Mém. Soc. Genève, XXXI (1890), 2, p. 164, t. vii, ff. 16–22; and Faune Rhiz. Léman (1902), p. 368, ff. 1–4 (p. 369); AVERINTZEV in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 248; and in Zool. Anzeig. XXXI (1907), p. 310; SCHOUTEDEN in Ann. Biol. Lacustre, I, 3 (1906), pp. 354, 356; MURRAY in Ann. Scott. Nat. Hist. 1907, p. 95.

Test small, ovoid in broad view, very transparent, the crown semi-circular; the sides tapering into a narrow neck; at the convex mouth slightly dilated, the lips having a thickened border. In narrow lateral view convex, tapering from the broadest diameter in nearly straight lines—sometimes slightly convex and then concave—downwards to the notched mouth. The entire surface covered with plates of varying pattern, mostly circular. Plasma colourless, always containing a quantity of chlorophyllous particles, large and small, mixed with oil-like globules and some granular matter, but never very dense. Pseudopodia thin, blunt, four to six, usually very active. The nucleus normally situated.

Dimensions: Length 50–70 μ; breadth 25–35 μ.

In *Sphagnum*, frequent. Dunham, Cheshire; Sychnant Pass, Carnarvonshire. Moel Siabod and above Dolgam, Capel Curig, N. Wales; and Killough, Co. Wicklow, Ireland (*J. Hopkinson*). Pentland Hills and Ben Ledi, Scotland (*W. Evans*).

This pretty little *Nebela* is easily recognized, and except that some examples are broader in proportion than others, it shows little tendency to vary. No other *Nebela* has the same thickened lips. The test, which is usually distinctly marked, is very transparent. The plasma, not occupying the whole of the interior, is attached to the walls and summit by extensions of ectoplasm. In the encysted state the plasma is drawn up towards the fundus, and appears as an elliptical compressed body, the rest of the cavity being unoccupied.

5. **Nebela carinata** (Archer) Leidy.

(Plate XXVI.)

Difflugia carinata ARCHER in Q. Jrn. Micr. Sci. (n.s.) VII (1867), p. 178; *op. cit.* IX (1869), t. xx, f. 12; XII (1872), p. 195; Jrn. Dublin Micr. Club, I, 2 (1867), p. 122; and *op. cit.* II, 1 (1872), p. 121.

Nebela carinata LEIDY (pars) in Pr. Acad. Philad. 1876, p. 118, ff. 10, 11; *op. cit.* 1879, p. 162; and Freshw. Rhiz. N. Amer. (1879), p. 154, t. xxiv, ff. 1–5, 9, 10; HITCHCOCK Synops. Freshw. Rhiz. (1881), p. 22; TARÁNEK in Sitzber. böhm. Ges. Wiss. 1881 (1882), p. 231; and in Abh. böhm. Ges. Wiss. (6) XI (1882), 8, p. 38, t. iii, ff. 1–6; t. iv, f. 7; BLOCHMANN Mikr. Thierw. Süsswass. (1886), p. 13, t. i, f. 26; and ed. 2 (1895), p. 17, t. i, f. 20; PENARD in Mém. Soc. Genève, XXXI (1890), 2, p. 160, t. vi, ff. 69–77; in Arch. Sci. nat. (4) VII (1890), p. 265; and Faune Rhiz. Léman (1902), p. 357, ff. 1–3; RHUMBLER in Zeits. wiss. Zool. LII, 4 (1891), p. 518; CASH in Tr. Manch. Micr. Soc. 1891 (1892), p. 51; LEVANDER in Acta Soc. Fauna Fenn. XII (1894), 2, p. 20; and *op. cit.* XX (1901), 8, p. 8; Daday in Termész. Füzetek, XX (1897), p. 154; Schaudinn in Deutsch-Ost-Africa, IV, 2 (1897), 19, p. 10; Eyferth Naturgesch. mikr. Süsswass. ed. 3 (1900), p. 264; G. S. West in Jrn. Linn. Soc., Zool. XXVIII (1901), p. 322; and in Ann. Scott. Nat. Hist. 1905, pp. 90, 92; Averintzev in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 241; Schouteden in Ann. Biol. Lacustre, I, 3 (1906), pp. 354, 355, f. 26; Landacre in Pr. Ohio Acad. Sci. IV, 10 (1908), p. 428; Murray in Ann. Scott. Nat. Hist. 1907, p. 95.

Test variable in outline, usually broader in proportion than in any of the preceding species, the lateral border, all round, from a short distance above the neck, expanded into a keel, which, in most examples, from a broadish base thins off to a sharp edge. The surface covered with scales of varying pattern, mostly polygonal, and not very distinctly marked. Plasma and pseudopodia similar to those of *N. collaris*, with the nucleus normally situated.

Dimensions variable: length 140–180 μ; breadth 110–130 μ.

Amongst *Sphagnum*, mostly in sub-alpine bogs; not common in lowland districts. Dunham, Cheshire; Tan-y-Bwlch and Llyn Idwal, Carnarvonshire; near Towyn, Merionethshire. Glyder Fach, N. Wales (*G. S. West*). Moel Siabod and above Dolgam, Capel Curig, N. Wales; and Calary Bog, Co. Wicklow, Ireland (*J. Hopkinson*). In the Highlands of Scotland as at Aberfoyle in Perthshire (*W. Evans*).

Archer first reported this species from Ireland, in 1866, and described it in the 'Proceedings of the Dublin Microscopical Club' under the name of *Difflugia carinata*. Its chief feature is the peculiar winged or carinate test, which in most of the forms observed is seen to be a thickening of the shell-margin, suddenly tapering to a sharp and in nearly all instances irregular edge. In one form, however, which we have found in great abundance on the margin of Llyn Idwal, the carina has not a thickened base, but springs direct from the margin as a flattened wing, and is of uniform thickness throughout. Usually the polygonal surface-markings are also faintly carried over the surface of the carina.

In most examples the plasma is more or less crowded with minute colourless globules and chlorophyllous food-particles. From the density of the granular protoplasm the pale nucleus is often hardly discernible. The body occupies usually the entire cavity of the test or nearly so.

A glance at the figures on Plate XXVI will show the great variability of the test of *N. carinata*, particularly in the degree of development of the carina and in its outline when the test is viewed on its broader surface. Not infrequently it has an outline, as figured by Penard ('Faune Rhiz. Léman,' p. 357), not unlike that of *N. collaris*, and similarly proportioned. Leidy ('Freshw. Rhiz. N. Amer.') represents it as being somewhat broader in proportion to the length, the wing more expanded and the mouth terminating a short neck. Cheshire examples for the most part exhibit the wing still more expanded laterally, making the breadth of the test, over all, nearly equal to the length, the lateral edges, from a broadly-arched crown, descending in straight lines down to the contracted mouth, which usually terminates a short neck (Pl. XXVI, fig. 5); whilst in other and more rare examples the general contour of the test is rotund, like that of *N. tincta*, also with a short neck (Pl. XXVI, fig. 9). The latter might almost be regarded as a distinct variety, but we are not satisfied, from the few examples as yet examined, of its permanence. Examples gathered in Merionethshire correspond closely to the Dunham ones (Pl. XXVI, fig. 8).

These different forms indicate a wide range of variability. Probably they are determined by the degree of development of the carina and have no specific or varietal significance.

6. **Nebela marginata** Penard.

(Plate XXVII, figs. 1 and 2.)

Nebela carinata LEIDY (pars) Freshw. Rhiz. N. Amer. p. 154, t. xxiv, ff. 6–8.

Nebela marginata PENARD Faune Rhiz. Léman (1902), p. 359, ff. 1–3; AVERINTZEV in Trudúi S.-Peterb. Obshch. XXXVI (1906), 2, p. 242; SCHOUTEDEN in Ann. Biol. Lacustre, I, 3 (1906), pp. 354, 355; MURRAY in Ann. Scott. Nat. Hist. 1907, p. 95.

Test chitinous, transparent, not so variable in form as in the preceding species, and larger than average examples of it; the arched crown (in lateral view), and the sides sometimes for a short way below the base of the crown, margined by a narrow keel, less prominent than that of *N. carinata*; the edges of the keel more or less irregular in outline. The sides of the test, below the crown, converging in straight (rarely concave) lines downwards to the mouth, which is truncated. The test in narrow lateral view biconvex above, strongly compressed, the sides tapering gradually downwards, the mouth being outlined by a shallow notch. The plasma, as in most of the *Nebelæ*, not filling the entire cavity of the test; attached to the fundus by extensions of its own substance; the nucleus normally situated and very distinct; the endoplasm containing also variously-sized chlorophyllous corpuscles, refringent globules, and some granular material. Pseudopodia five or six in number, digitate, usually simple, and colourless.

Dimensions: Length 140–170 μ; breadth about 120 μ.

In moist *Sphagnum*, not common. Dunham, Cheshire; margin of Llyn Idwal, Carnarvonshire, and other localities in North Wales. Moel Siabod, at 2500 ft. (*J. Hopkinson*).

This is liable to be confused with *N. tubulosa* Penard; it differs from that species in having the sharp edge, or keel, confined to the upper half of the test, whilst *N. tubulosa* has its entire margin, from the crown to the mouth, margined or roughly carinated, with an irregular edge. In the latter species the sides are convex down to a point where the test becomes narrowed and a short but distinct neck is formed. This perhaps, more than any other feature, distinguishes *N. tubulosa* from the species under consideration. *N. marginata*, moreover, is destitute of any marginal pore, and in narrow lateral view the test is more abruptly conical.

7. **Nebela tubulosa** Penard.

(Plate XXVII, figs. 3 and 4; and fig. 93 in text.)

Nebela collaris (pars) Leidy Freshw. Rhiz. N. Amer. p. 147, t. xxiii, ff. 1–6.

Nebela tubulosa Penard in Mém. Soc. Genève, XXXI (1890), 2, p. 159; Faune Rhiz. Léman (1902), p. 353, ff. 1–5 (p. 354); and in Pr. R. Soc. Edinb. XXV, 8 (1905), p. 594; Schouteden in Ann. Biol. Lacustre, I, 3 (1906), p. 355 (note); Murray in Ann. Scott. Nat. Hist. 1907, p. 95.

Test in broad view arcuate above; its sides biconvex, except where they converge to form the neck; the body presenting a more or less ovate outline, and the neck truncated at the extremity. The lateral margins, both of the sides and crown, acute, so that a sharp edge is produced all round, of which the outline is more or less broken. Test bi-convex in transverse view, its apex acute, and the neck, at about one-third the length of the test from the mouth, with a marginal perforation on each side, marked generally by a slight swelling; the pore sometimes hardly perceptible in the living animal, but careful examination will generally reveal it. The entire envelope tinted a chocolate-brown, which deepens with age; in the upper portion with a surfacing of variously-shaped transparent plates, sometimes distinct, but in other cases faint in outline, oval or quadrangular, and rather loosely arranged. The lower part of the test, and especially the neck, in place of these, covered with fine punctulations, which may be due to raised points of the chitinous substance producing an appearance of roughness. Plasma, nucleus, and pseudopodia as in the allied species.

Dimensions: Length 190–220 μ.

In wet *Sphagnum*, not common. Dunham, Cheshire; Tan-y-Bwlch, Sychnant Pass, Llyn Idwal, and Towyn, N. Wales. Above Dolgam, Capel Curig, N. Wales; and Killough, Co. Wicklow, Ireland (*J. Hopkinson*). Loch Ness, Scotland (*D. J. Scourfield*).

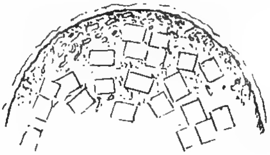


FIG. 93.—Quadrangular scales on upper surface of test of *Nebela tubulosa*. × 400.

This species may generally be recognized by the chocolate colour of its test, and the lateral pores just above the neck. These, however, are not the only distinctive features. The minute punctulations on the neck, and particularly for a short way upwards from the mouth, are peculiar. The upper portion of the test presents quite different features; it has a surfacing of variously-formed scales, the outlines of which are rendered somewhat indistinct by the surface colour, but frequently we have been able to make out an arrangement, just below the crown, of two or three irregularly-disposed rows (following the outline of the test) of quadrangular plates closely resembling those of *Quadrula*, but rarely touching at their edges. So closely do they resemble *Quadrula* scales that the explanation suggests itself that they may be the disintegrated remains of *Quadrula* tests which the *Nebela* has appropriated for furnishing its own.

These plates are distinctly seen under a power of about 400–500 diameters.

The occurrence of *N. tubulosa* seems to be sporadic. It is not often met with, but where it occurs it is usually plentiful. Such was the case in the Sychnant Pass, and at Llyn Idwal. It occurred in the spring of 1904 in great abundance in *Sphagnum* gathered at Dunham during the preceding summer, and kept through the winter in a garden frame.

8. **Nebela equicalceus** Leidy.*

(Fig. 94.)

Difflugia (Nebela) equicalceus LEIDY in Pr. Acad. Philad. 1874, p. 156.

Nebela equicalceus LEIDY in Pr. Acad. Philad. 1876, p. 118, ff. 12, 13.

Nebela hippocrepis LEIDY (pars) Freshw. Rhiz. N. Amer. (1879), p. 156, t. xxv, ff. 9–14; HITCHCOCK Synops. Freshw. Rhiz. (1881), p. 22; TARÁNEK in Sitzber. böhm. Ges. Wiss. 1881 (1882), p. 231; and in Abh. böhm. Ges. Wiss. (6) XI (1882), 8, p. 41; (*cf.* BLOCHMANN Mikr. Thierw. Süsswass. ed. 2 (1895), p. 17;) EYFERTH Naturgesch. mikr. Süsswass. ed. 3 (1900), p. 265; G. S. WEST in Jrn. Linn. Soc., Zool. XXVIII (1901), p. 323; PENARD Faune Rhiz. Léman (1902), p. 575, f. 6 (p. 572); AVERINTZEV in Trudui S.-Peterb. Obshch. XXXVI (1906), p. 237; SCHOUTEDEN in Ann. Biol. Lacustre, I, 3 (1906), pp. 353, 355.

Test in broad view pyriform, with a thick, blunt, solid carina extending round the convex crown, down the lateral borders, and ending in digitate processes which project downwards into the cavity; the mouth transversely oval, its outline convex. Body of the test with a surfacing of transparent circular discs; its margins pale straw-coloured, and homogeneous. The protoplasm, in colour and other respects as in *N. collaris* and its allies; nucleus normal; pseudopodia as in *N. carinata*.

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* [*Nebela hippocrepis* Leidy: CASH, MS.]

Dimensions: Length of test 183 μ; breadth 133 μ; breadth of mouth 29 μ (*G. S. West*).

In wet *Sphagnum*; recorded only in Britain by West ('Journal of the Linnean Society,' XXVIII, Zool., p. 323) from below the outlet of Llyn Idwal, North Wales.

Leidy considers this species related to *N. carinata*. It is rare in America as well as in Europe. That author describes the horse-shoe-shaped keel as extending below the crown for about two-thirds the length of the test. The structure of the test, independently of the keel, is the same as in *N. collaris*.

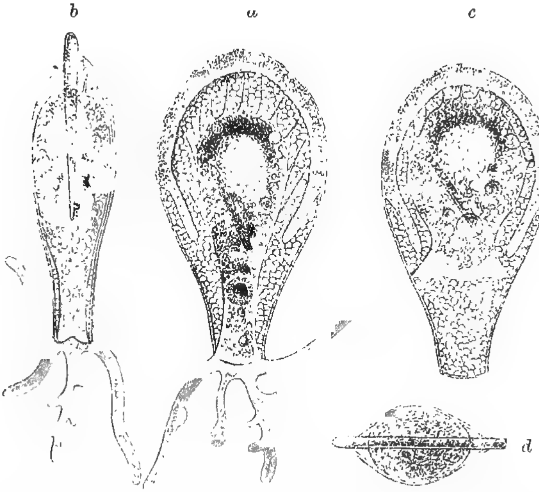


FIG. 94.—*Nebela equicalceus.* After Leidy *loc. cit.* (reduced to three-fifths). *a* and *b*, broad and narrow views of an active individual; *c*, broad view of the same with the sarcode retracted; *d*, view from above as seen in the normal position. × 150.

[After giving the name *equicalceus* to this species, Leidy changed it to *hippocrepis*, but the author of a specific name which he has once published can only change it (further than correcting a mis-spelling) if it is found to be pre-occupied.]

9. **Nebela barbata** Leidy.

(Plate XXVII, figs. 5 and 6; and fig. 95 in text.)

Difflugia (*Nebela*) *barbata* LEIDY in Pr. Acad. Philad. 1874, p. 157.

Nebela barbata LEIDY in Pr. Acad. Philad. 1876, p. 119, f. 18; *op. cit.* 1879, p. 162; and Freshw. Rhiz. N. Amer. (1879), p. 159, t. xxiv, ff. 14–17; HITCHCOCK Synops. Freshw. Rhiz. (1881), p. 23; SCHEWIAKOFF in Mém. Acad. St. Pétersb. (7) XLI (1893), 8, p. 98; SCOURFIELD in Pr. Zool. Soc. 1897, p. 787; EYFERTH Naturgesch. mikr. Süsswass. ed. 3 (1900), p. 265; LEVANDER in Acta Soc. Fauna Fenn. XX (1901), 8, p. 11; G. S. WEST in Journ. Linn. Soc., Zool. XXVIII (1901), p. 323.

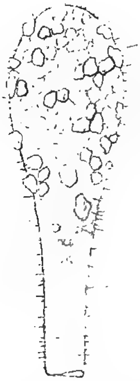


FIG. 95.—*Nebela barbata.* Llyn Llydaw, Snowdon. From a drawing by G. S. West (reduced). × 325.

Test in broad view flask-shaped, with an ovoid body and cylindroid neck, the latter about equal in length to the body; the mouth, in broad view, slightly expanded and convex. In narrow lateral view compressed; the sides tapering gracefully into the neck, which is narrow and terminated by the notched mouth. The whole structure gracefully proportioned and translucent, with a surfacing of comparatively large circular discs,—their outlines sometimes hardly perceptible—accompanied, according to Leidy (who named the species from American examples) with an arrangement of short, delicate, hair-like spicules. The latter, however, are rarely observed in British examples.

Dimensions: Length 80–160 μ; breadth 40–60 μ.

In *Sphagnum* from Cader Idris, Towyn, Tan-y-Bwlch, and near Criccieth. Also reported by G. S. West from Llyn Llydaw, Snowdon, with spicules which measured about 15 μ in length (fig. 95). Moel Siabod and above Dolgam, Capel Curig, N. Wales (*J. Hopkinson*). Loch Ness, Scotland (*J. Murray*).

It ought not to be possible to confound this species, as is sometimes done, with *N. lageniformis.* It is much more delicate, and has a longer neck in proportion to the size of the body; the neck, moreover, is of uniform width, the sides being as nearly as possible parallel, whilst in narrow lateral view the mouth is prominently notched. Living examples seem to be rarely met with.

10. **Nebela galeata** Penard.

(Plate XXVII, figs. 7–9.)

Nebela collaris LEIDY (pars) Freshw. Rhiz. N. Amer. (1879), p. 145, t. xxiii, ff. 2–7.

Nebela collaris var. *genuina* TARÁNEK in Abh. böhm. Ges. Wiss. (6) XI (1882), 8, p. 32, t. i, ff. 1, 2.

Nebela galeata PENARD in Mém. Soc. Genève, XXXI (1890), 2, p. 161, t. vi, ff. 78–84; and Faune Rhiz. Léman (1902), p. 360, ff. 1–6 (p. 361); AVERINTZEV (pars) in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 243; SCHOUTEDEN (pars) in Ann. Biol. Lacustre, I, 3 (1906), p. 355.

A much finer species than either *N. marginata* or *N. americana;* the test elongated, with an arched crown in face view, the margin on either side descending without curvature to the corners of the mouth; the margin thickened all round. In narrow lateral view the thickened edge of nearly uniform width from the crown (where it forms a distinct protuberance) downwards, in this respect presenting a contrast to the knife-like edge in *N. carinata* or *N. marginata;*

in dorsal view, likewise, the edge presents a uniform thickness; in transverse section, therefore,—that is with the crown directed towards the eye—the form is that of a compressed ellipse, with a longitudinal band down the centre, of which the extremities extend slightly beyond the marginal limits. Plasma normal, not filling the entire cavity of the test, attached to the dome by threads of ectoplasm, and containing, besides a conspicuous nucleus, normally situated, a considerable proportion of chlorophyllous and colourless corpuscles of variable size. Pseudopodia freely produced, showing a tendency to bifurcate or become branched.

Dimensions: 180–200 μ; breadth 100 μ.

In *Sphagnum*, Dunham, Cheshire.

N. galeata is a robust species, possessing a test which is very graceful in its symmetry, and beautiful as a microscopic object. The thickened border is unmistakable, and appears prominently when the test is examined on its lateral edge, terminating the sloping crown with a distinct knob. The organism is very active; the pseudopodia appear incessantly in motion; and the test is very frequently seen erected, presenting the elliptical crown with its thickened edge to the eye.

11. **Nebela americana** Taránek.

(Plate XXXI, figs. 15–18; and fig. 96 in text.)

Nebela americana TARÁNEK (pars) in Sitzber. böhm. Ges. Wiss. 1881 (1882), p. 231; and in Abh. böhm. Ges. Wiss. (6) XI (1882), 8, p. 40, t. iii, ff. 15, 16; PENARD Faune Rhiz. Léman (1902), p. 363, ff. 1–6; AVERINTZEV in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 252; SCHOUTEDEN in Ann. Biol. Lacustre, I, 3 (1906), pp. 354, 356.

Nebela longicollis PENARD in Mém. Soc. Genève, XXXI (1890), 2, p. 158, t. vi, ff. 45–49; and in Amer. Natur. XXV (1891), p. 1073.

Test elongated, much narrower than that of *N. marginata*, the lateral margins (as the test lies upon its side) descending from the arched crown, each in a straight line, to the corners of the contracted mouth, which is slightly convex. A pore on each side of the test, about one-third of the distance upwards from the mouth, often marked by a slight prominence. Substance of the test chitinous, with a surfacing of round or angular transparent plates touching at their edges. The test in narrow lateral view slightly inflated above—the crown sometimes tapering to a blunt apex—and the lower part produced into a narrow neck, which is terminated by the notched mouth. Plasma often crowded with yellowish-green corpuscles, refringent globules and granular matter nearly obscuring the nucleus; the pseudopodia few in number, simple.

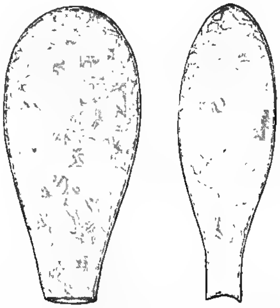


FIG. 96.—*Nebela americana;* broad and narrow views. Tan-y-bwlch, N. Wales. × 220.

Dimensions: Length 160–175 μ; breadth 65–75 μ; at mouth 30–35 μ.

In moist *Sphagnum*, Dunham Marsh, 1903; near Towyn and at Tan-y-Bwlch, N. Wales. Loch Ness, Scotland (*J. Murray*).

This species has been regarded by some authors as identical with *N. barbata* Leidy, but the two are quite distinct. *N. barbata* usually has much the smaller test; it has a long and slender neck, and is altogether much more delicate than *N. americana*. The latter has a brownish test, with a surfacing of circular or polygonal plates; the sides are straight from the crown downwards to the mouth, the lines on each side being interrupted only by the slight swelling (as in *N. tubulosa*) which indicates the position of the lateral pores. In empty tests the appearance is sometimes presented of a distinct line, convex on its lower surface, carried transversely across the test and connecting the two pores.

12. **Nebela flabellulum** Leidy.

(Plate XXVIII, figs. 1–6.)

Difflugia (*Nebela*) *flabellulum* Leidy in Pr. Acad. Philad. 1874, p. 157.

Nebela flabellulum Leidy in Pr. Acad. Philad. 1876, p. 118, ff. 6, 7; *op. cit.* 1877, p. 264; 1879, p. 162; 1880, pp. 333, 337; and Freshw. Rhiz. N. Amer. (1879), p. 152, t. xxiii, ff. 8–19; Hitchcock Synops. Freshw. Rhiz. (1881), p. 21; Taránek in Abh. böhm. Ges. Wiss. (6) XI (1882), 8, p. 33, t. i, ff. 14–17; Penard (pars) in Mém. Soc. Genève, XXXI (1890), 2, p. 160, t. vi, ff. 62–66; Harvey in Amer. Natur. XXII (1888), p. 73; Lord in Tr. Manch. Micr. Soc. 1891 (1892), p. 56; Stenroos in Acta Soc. Fauna Fenn. XVII (1898), 1, p. 35 etc.; Lagerheim in Förh. Geol. Fören. Stockholm, XXIII (1901), p. 515; Levander in Acta Soc. Fauna Fenn. XVIII (1900), 6, p. 33 etc.; and *op. cit.* XX (1901), 8, p. 9; G. S. West in Jrn. Linn. Soc., Zool. XXVIII (1901), p. 322; in Ann. Scott. Nat. Hist. 1905, pp. 90, 92; and in Tr. R. Irish Acad. B. 2 (1906), p. 96; Beardsley in Tr. Amer. Micr. Soc. (1902), p. 57; Murray in Ann. Scott. Nat. Hist. 1907, p. 95.

Nebela collaris var. *flabellulum* Greeff in Sitzber. Ges. Nat. Marburg, 1888, 3, p. 111; Schewiakoff in Mém. Acad. Sci. St. Pétersb. (7) XLI (1893), 8, p. 98.

Nebela flabellulum-collaris Penard Faune Rhiz. Léman (1902), p. 366.

Nebela collaris (pars) Averintzev in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 251; Schouteden (pars) in Ann. Biol. Lacustre, I, 3 (1906), pp. 354, 356.

Test generally rather smaller than that of *Nebela tincta;* in broad view expanded laterally and fan-shaped, its breadth invariably exceeding the vertical dimension; much compressed; the sides abruptly narrowed below into a short cylindrical neck. The body in lateral view compressed into an ellipse, the neck slightly constricted immediately above the mouth; in dorsal (transverse) view the appearance of the test that of a perfect ellipse, the small mouth corresponding with it in figure. The test structurally of chitinous membrane, and colourless, with a surfacing of oval plates, uniform in size, and generally without any other ornamentation. Plasma not differing from that of *N. collaris;* the nucleus normally situated; the pseudopodia few in number and scarcely so thick as those of *N. tincta.*

Dimensions: Length 80–90 μ; breadth 90–110 μ.

Chelford and Delamere, Cheshire; Llyn Idwal and near Criccieth, N. Wales. Moel Siabod and above Dolgam, Capel Curig, N. Wales; Killough and Calary Bog, Co. Wicklow, Ireland (*J. Hopkinson*). Loch Ness, Scotland (*J. Murray*). Bavelaw Bog, Midlothian, Scotland (*W. Evans*).

Nebela flabellulum is much less frequently met with than most of its allies. Its peculiarly inflated sides sufficiently distinguish it. It is to be looked for in wet *Sphagnum,* and seems to affect sub-alpine districts more than lowland bogs.

13. **Nebella acolla** *sp. nov.*

(Plate XXVIII, figs. 7 and 8.)

Test broadly elliptic, broader than long, without neck, the mouth, ventrally situated, being invisible, its presence (when the test is lying on its side) indicated by a slight thickening of the lower margin. The test in face view narrowly ovate, the orifice, presented directly to the eye, appearing as an oval slit in the chitinous membrane; structure thin and transparent, and with a surfacing of minute circular or polygonal plates, scarcely touching at the edges. The plasma and its contents unknown.

Dimensions: Narrowest diameter (from mouth to crown of test) 60 μ; breadth (or longest diameter) 70 μ; breadth in narrow lateral view 35 μ.

In *Sphagnum* gathered by Mr. Hopkinson at Capel Curig in June, 1908 [at the source of a stream above Dolgam].

Only empty tests, but these very perfect ones, were observed. They were transparent and colourless, and structurally had all the characters of *Nebela*, leaving no doubt as to that being the genus to which the organism must be referred. At the same time they differed from most other members of the genus in being absolutely without neck. A neck, however short, would have justified a reference of the form to *N. flabellulum*, though the surfacing plates and their disposition differed totally from what is usually found in that species. The test, moreover, was smaller than that of *N. flabellulum*. It is to be regretted that no living example could be found. Even the empty tests were scarce.

14. **Nebela dentistoma** Penard.

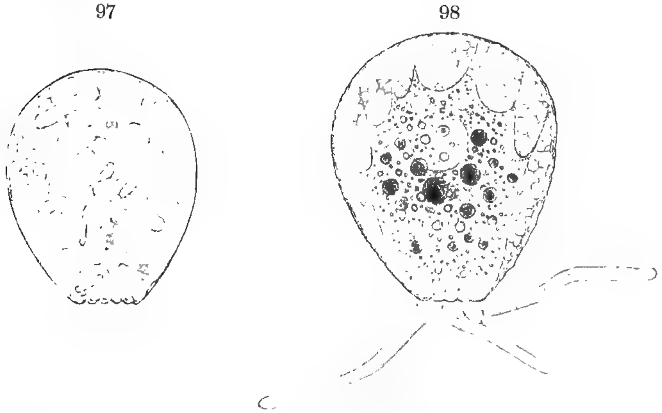
(Plate XXVIII, figs. 9–11; and figs. 97 and 98 in text.)

Nebela collaris Leidy (pars) Freshw. Rhiz. N. Amer. (1879), p. 145, t. xxiv, f. 12.

Nebela dentistoma Penard in Mém. Soc. Genève, XXXI (1890), 2, p. 162, t. vi, ff. 98–100; t. vii, ff. 1–5; and in Amer. Nat. XXV (1891), pp. 1071, 1074; G. S. West in Jrn. Linn. Soc., Zool. XXVIII (1901), p. 322; *op. cit.* XXIX (1903), p. 114; and in Ann. Scott. Nat. Hist. 1905, p. 92; Schouteden in Ann. Biol. Lacustre, I, 3 (1906), p. 355 (note).

Nebela crenulata Cash in Tr. Manch. Micr. Soc. 1891 (1892), p. 50, t. ii, f. 18; Penard in Arch. Sci. nat. (3) XXVIII (1893), p. 182; *op. cit.* (4) VII (1899), p. 265 etc.; and Faune Rhiz. Léman (1902), p. 370, ff. 1–5; Averintzev in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 247; Murray in Ann. Scott. Nat. Hist. 1907, p. 95.

Test variable, moderately compressed, ovoid to rotund, destitute of a neck, the sides, in broad lateral view, sloping convexly from the arched crown downwards to the mouth, the margin of which is crenulate. In its structure very variable; the external surface covered with small, lenticular or oval transparent plates or discs, generally of uniform size, mixed in some examples with angular plates or short stoutish rods of chitinous or siliceous substance. The outer margin, as well as the mouth, with a more or less crenulate outline, on account of the prominence there of the particles of which the test is composed, and in such cases the structure is brittle and easily fractured under pressure. Protoplasm and nucleus corresponding with those of the allied species; the pseudopodia, four or five in number, colourless, simple, or sparingly branched.



Figs. 97 and 98.—*Nebela dentistoma:* 97, an empty test from Dunham, Cheshire, × 300; 98, an active individual from Knutsford, Cheshire, × 350.

Dimensions: Length 95–115 μ; breadth 73–90 μ.

In *Sphagnum* and amongst the rootlets of *Bartramia* and other mosses in boggy places. Frequent in Cheshire, in North Wales, as at Tan-y-Bwlch, and in Scotland. Near Sutton Broad, Norfolk (*E. Gurney*). Glyder Fawr, N. Wales, at 2700 feet (*G. S. West*). Moel Siabod, N. Wales, at 2500 feet; Killough and Calary Bog, Co. Wicklow, Ireland (*J. Hopkinson*). Loch Ness, Scotland (*D. J. Scourfield*).

This species may readily be distinguished from forms of *N. collaris* Leidy, and of *N. tincta* (Leidy), by the form and structure of the test as well as the character of the mouth. When a test of *N. dentistoma* is crushed, especially if it be largely composed of lenticular pellets, an uneven fracture is produced. The fracture always follows the lines of least resistance; it separates the pellets but does not break them; whereas a test of *N. collaris* or *N. tincta* similarly treated would merely be pressed out of shape. Tests of *N. dentistoma* occurring in clean *Sphagnum* are beautifully transparent. The protoplasm of the living organism is colourless, except for the presence of chlorophyllous food-particles. As a rule the nucleus is easily distinguishable and one or more clear vacuoles are usually present.

Near Llyn Idwal, and in other parts of North Wales, we have frequently met with a form which, whilst presenting many of the characters of *N. dentistoma*, is neither crenulate nor dentate, but almost smooth at the mouth and on the lateral margins. The test is usually smaller than that of typical *dentistoma*, and is generally covered with diaphanous scales of irregular shape. Were it not, in other respects, so close to the species under consideration, it might justifiably be regarded as distinct.

[This form (Pl. XXVIII, figs. 12 and 13) appears at least to merit varietal rank, and may be called var. *lævis*, that name, though not in the MS. of this work, being written by Mr. Cash in our Wicklow list. It occurred in a small sphagnous pool on the Great Sugar Loaf Mountain (the Killough locality).]

15. **Nebela vitræa** Penard.

(Plate XXVIII, figs. 14–17.)

Nebela vitræa Penard in Rev. Suisse Zool. VII, 1 (1899), p. 43, t. iv, ff. 5–16; Faune Rhiz. Léman (1902), p. 372, ff. 1–8; Sarc. grands Lacs (1905), p. 40, 2 ff. (p. 41); and ? in Pr. R. Soc. Edinb. XXV, 8 (1905), p. 594; Steinmann in Ann. Biol. Lacustre, II, 1 (1907), pp. 38, 131.

Test about the size of the preceding and liable to be mistaken for it; very transparent; ovoid in general outline, compressed laterally, and surfaced with diaphanous angular scales adhering at their edges, rarely overlapping; the marginal outline often slightly irregular from the protrusion of these scales; mouth narrow, truncated, its margin irregular in outline, generally bordered by a ring of minute irregularly-shaped sand-grains. The plasma as in the preceding species, not filling the cavity of the test; nucleus normally situated; the pseudopodia few—sometimes a single granular pseudopodium only, extending in length to twice the longitudinal diameter of the test.

Dimensions: Length 95–120 μ (*Penard*, 170–200 μ).

In *Sphagnum*, Dunham, Cheshire; also near Towyn, Merionethshire; frequently associated with the preceding species. Loch Ness, Scotland (*D. J. Scourfield*).

There is little difficulty in distinguishing this species from *N. dentistoma* Penard when the structure of the test is examined. The mouth of *N. vitræa* is never crenulate; its outline might more correctly be described as irregularly dentate, from the prominence of the marginal sand-grains; the oral extremity of the test is more narrowed than that of the preceding species; but it must be admitted that the relationship of the two is very close.

16. **Nebela tenella** Penard.

(Plate XXVIII, figs. 18 and 19.)

Difflugia annulata Ehrenberg ? in Abh. Akad. Wiss. Berlin, 1871 (1872), p. 249, t. iii, 1, f. 19.

Nebela tenella Penard in Arch. Sci. nat. (3) XXIX (1893), p. 182, t. iii, ff. 8, 9; and Faune Rhiz. Léman (1902), p. 375, ff. 1–3 (p. 376) (; *cf.* Averintzev in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 253).

Test small; its broadly ovoid body terminated by a prominent neck, which is thickened at the extremity in both the broad and narrow lateral views; compressed; of chitinous substance and more or less transparent.

The surface crinkled or uneven, without a definite arrangement of the amorphous scales which cover it; the marginal outline also being roughish. General colour a light grey.

Dimensions : Length 70–75 μ.

In *Sphagnum*, chiefly from sub-alpine districts in Wales and Scotland. Above Dolgam, Capel Curig (*J. Hopkinson*). Pentland Hills and Ben Ledi, and in gatherings from Aberfoyle (*W. Evans*).

Nebela tenella has a character of its own in the thickened oral extremity, and in the generally rough surface of the chitinous test, which detracts somewhat from its transparency. It affects sub-alpine bogs, and (so far as our experience goes) does not occur in lowland districts. We have frequently found it encysted, the cyst appearing as a round ball occupying the centre of the test in its broadest part.

17. **Nebela parvula** *sp. nov.*

(Plate XXVIII, figs. 20 and 21.)

Test ovoid, small, membranous and transparent, with a surfacing (sometimes almost or quite imperceptible) of minute discs, colourless or yellowish; perfectly smooth. The outline ovoid (narrower in some examples than in others) complete down to the neck, which is short and abrupt; the mouth truncated. In narrow lateral view the test strongly compressed; in dorsal, or transverse view, narrowly elliptic. Protoplasm not filling the entire cavity, attached to the test in its upper portion by threads of ectoplasm; the nucleus normally situated but more or less obscured by the granular protoplasm. Pseudopodia four to six in number, simple, short, and rather thin.

Dimensions : Length 80 μ; breadth 55 μ.

In *Sphagnum*. Sychnant Pass, N. Wales. Above Dolgam, Capel Curig, N. Wales (*J. Hopkinson*). Pentland Hills, Midlothian; and Ben Ledi, Scotland, in

Sphagnum gathered by Mr. W. Evans in the summer of 1906, abundant.

This pretty species was taken at first for a diminutive form of *N. collaris* Leidy, or one of its allies, but its occurrence in *Sphagnum* from the localities mentioned was so frequent, and the characters of the individuals were so constant, that careful study led us to the conclusion that it could not be referred to any previously-described species. The test is remarkably transparent. A form closely resembling it, but rather longer in proportion, occurred at Dunham in the previous year. It may not improbably have been the same, the difference being due to environment, but without more examples for comparison (only one or two were found in Cheshire) it is impossible to say definitely.

18. **Nebela caudata** Leidy.

(Fig. 98.)

Nebela caudata LEIDY in Proc. Acad. Philad. 1876, p. 58, and Freshw. Rhiz. N. Amer. (1879), p. 160, t. xxvi, ff. 21–24; HITCHCOCK Synops. Freshw. Rhiz. (1881), p. 23; EYFERTH Naturgesch. mikr. Süsswass. ed. 3 (1900), p. 265; PENARD Faune Rhiz. Léman (1902), p. 574, f. 5 (p. 572); ? in Pr. R. Soc. Edinb. XXV, 8 (1905), p. 594; and in Jrn. R. Micr. Soc. 1907, p. 278; AVERINTZEV in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 235; MURRAY in Pr. R. Soc. Edinb. XXV, 8 (1905), p. 609; CUSHMAN in Amer. Natur. XL (1906), p. 273; SCHOUTEDEN in Ann. Biol. Lacustre, I, 3 (1906), pp. 353, 354.

This apparently scarce rhizopod is described by Leidy as possessing an ovoid compressed test, "with from four to five naked, blunt, conical or clavate processes projecting from the lateral borders and summit of the fundus"; the mouth transversely oval. The structure resembles that of *N. collaris*, being transparent and colourless, but the surface-markings are usually less distinct. The plasma is likewise colourless.

Dimensions: Length about 90 μ; breadth 70 μ.

Rare in Britain. Reported (with a query) by Dr. Penard ('Proc. Royal Society of Edinburgh,' 1904–5) as occurring in a gathering from Loch Ness, sent to him for examination by Mr. James Murray; and afterwards by Mr. Murray as having been observed there by Mr. Scourfield.

This is the only known species of *Nebela* possessing any kind of caudal appendage. Though abnormal in that respect, the structure of the test otherwise seems to conform to that of the genus. The processes are of the same chitinous substance as the test, and grow out of it; they are irregularly disposed, and blunt at their extremities; in some cases curved. The test, in broad view, has convex sides, which descend evenly down to the truncated mouth, but in narrow lateral view a distinct neck is shown, the test being strongly compressed, particularly in its lower half.

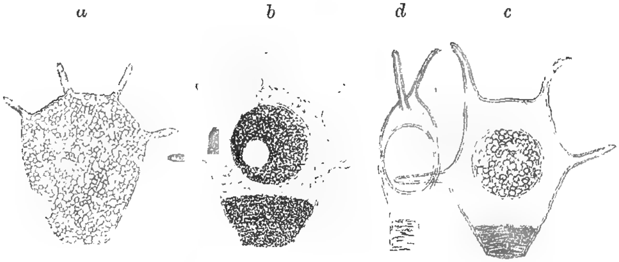


Fig. 99.—*Nebela caudata*. After Leidy, *loc. cit.* (reduced to one-half). *a*, broad view of an empty test; *b* and *c*, broad views of two encysted individuals; *d*, narrow view of the latter. × 250.

[19. **Nebela triangulata** (Lang).

(Fig. 99.)

Difflugia triangulata Lang in Q. Jrn. Micr. Sci. (n.s.) V (1865), p. 285, 2 ff. (p. 285); Archer in Q. Jrn. Micr. Sci. (n.s.) VII (1867), pp. 174, 177; *op. cit.* XII (1872), p. 195; in Jrn. Dublin Micr. Club, I, 2 (1867), pp. 118, 121; and *op. cit.* II, 1 (1872), p. 121.

Test rather small, very transparent, composed of minute angular plates of fairly regular size; in front view forming an irregular triangle, the anterior apex truncated for the aperture which has a slightly curved margin, the posterior apices produced into short blunt processes diverging laterally, margin of test between these apices convex; in side view very narrow, appearing like "a cocked hat turned edgeways.* Plasma when the pseudopodia are extruded occupying about a third of the interior of the test; pseudopodia few, rather long, simple or slightly branched, linear, extremities obtuse.

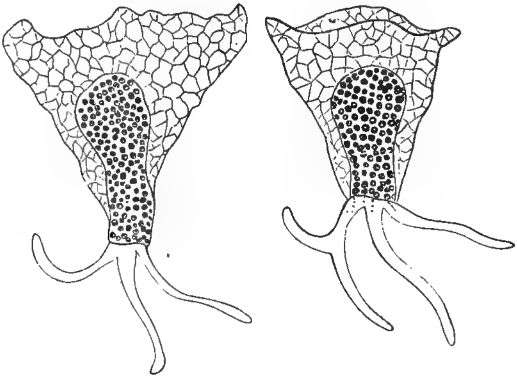


Fig. 100.—Broad views of two examples of *Nebela triangulata.* After Lang, *loc. cit.* (slightly reduced). × ? (The magnification given by the author appears to be incorrect.)

Dimensions: "Much smaller" than either "*Difflugia proteiformis*" or *Lesquereusia spiralis* (with which it was associated).

(?) Neighbourhood of Reading, Berkshire (*F. A. Lang*). Carrig Mountain and Connemara, Ireland (*W. Archer*).

Lang, in his description of this species, says that the carapace "is so remarkably transparent that the animal is seen, as through a glass case, freely suspended in the interior, and its surface is covered with markings of almost mathematical regularity." He proceeds: "I at first considered that this carapace was constructed of very minute pieces of pure diaphanous silica cemented together; but as, on drying it and subjecting it to the flame of a spirit-lamp, it becomes more or less distorted, and the markings are almost obliterated, I have come to the conclusion that it is more likely of a membranous nature."

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* The Conchulina when active usually have the fundus above and the aperture below, but they are more frequently represented in the reverse position, to which this remark applies.

Neither locality nor habitat is given, but as the article is signed "Fred. H. Lang, Reading," it may be assumed that the rhizopod was found by him in the neighbourhood of that town. It occurred in tolerable abundance.]

[Var. **bicornis** (G. S. West). (Fig. 101.)

Nebela bicornis G. S. West in Ann. Scott. Nat. Hist. 1905, p. 91, ff. A–E (p. 93).

Test similar in size and shape to that of the type, the posterior processes or "horns" more pronounced, being longer and narrower; aperture rather wider and minutely in place of broadly undulate; the minute plates composing the test more oblong, their axes (with the animal in its normal position) vertical. "Basal view of shell elliptical with produced extremities, mouth subcircular or rotund elliptic."

Dimensions: Length of test 96–117 μ; extreme breadth 86–101 μ; width of aperture 23–25 μ.

Plankton of Loch Shiel, Inverness, Scotland (*G. S. West*).

This form differs so little from *Nebela triangulata*, so far as can be judged from the meagre description given of that species by its author and the absence of a sketch of the oral view, that it can only be considered as a variety. The pseudopodia were not seen, all the individuals examined being "more or less encysted, the body-protoplasm exhibiting the form of a globular mass in the widest part of the shell." This it may be assumed from Lang's figures would be the form assumed in *N. triangulata* on the encystment of the plasma.

Both these forms should be compared with the *Nebela bipes* of Carter (see p. 98). If we assume that to be a good species and not a malformation, they may only be varieties of it, differing chiefly in the plates of the test being angular instead of circular. If so it is curious that they should have been found only at distances so wide apart, *N. bipes* in Devonshire and Scotland, *triangulata* in Berkshire and Ireland, and *bicornis* —much more nearly allied to *triangulata* than that is to *bipes*—in Scotland.

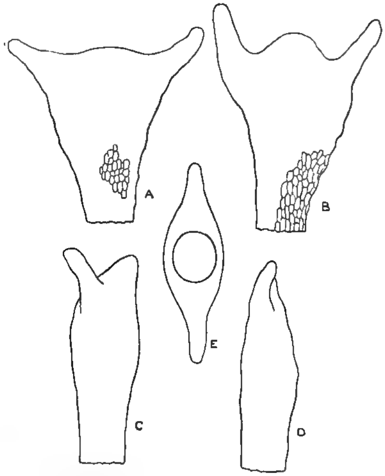

FIG. 101.—*Nebela triangulata* var. *bicornis*. After G. S. West, *loc. cit.* (reduced to one-half). A and B, front views of two examples; C and D, side views; E, oral view. × 260.

Drawings and descriptions of the two forms were sent by the writer to Mr. Cash, but unfortunately too late for him to consider them.]

Genus 26. **QUADRULA** F. E. Schulze, 1875.

Difflugia (pars) Wallich in Ann. Nat. Hist. (3) XII (1863), p. 458.
Quadrula F. E. Schulze in Arch. mikr. Anat. XI, 2 (1875), p. 329.

Test pyriform, sub-globose, or discoid, consisting of a homogeneous chitinous film, with quadrangular plates of siliceous or calcareous substance superimposed, the plates generally lying in oblique series, their edges touching (rarely overlapping) and sometimes loosely arranged. Protoplasm and pseudopodia not differing from those of *Difflugia*; uninuclear.

1. **Quadrula symmetrica** (Wallich) F. E. Schulze.

(Plate XXIX, figs. 1–3; and fig. 101 in text.)

Difflugia proteiformis var. *symmetrica* Wallich in Ann. Nat. Hist. (3) XII (1863), p. 458, t. viii, f. 16.
Difflugia pyriformis var. *symmetrica* Wallich in Ann. Nat. Hist. (3) XII (1863), p. 467; and *op. cit.* (3) XIII (1864), p. 232, t. xvi, f. 26.
Difflugia symmetrica Wallich in Ann. Nat. Hist. (5) XVI (1885), p. 463, f. 1.
Difflugia assulata Ehrenberg in Abh. Akad. Wiss. Berlin, 1871 (1872), pp. 246, 249, t. ii, ff. 4, 5.
Difflugia carolinensis Ehrenberg in Abh. Akad. Wiss. Berlin, 1871 (1872), pp. 246, 250, 274, t. iii, f. 14.
Difflugia leptolepis Ehrenberg in Abh. Akad. Wiss. Berlin, 1871 (1872), pp. 254, 264, 274, t. iii, f. 15.
Quadrula symmetrica F. E. Schulze in Arch. mikr. Anat. XI, 2 (1875), p. 329, t. xviii, ff. 1–6; Leidy (pars) in Pr. Acad. Philad. 1875, p. 415; *op. cit.* 1879, p. 162; and Freshw. Rhiz. N. Amer. (1879), p. 143, t. xxiv, ff. 20–24; Archer in Q. Jrn. Micr. Sci. (n.s.) XVII (1877), p. 112, t. viii, f. 6; and in Jrn. Dublin Micr. Club, III, 2 (1877), pp. 128, 230, t. viii, f. 6; Bütschli in Bronn's Thier-Reichs, I, 1 (1880), t. ii, f. 12; Lanessan in Rev. internat. Sci. VI (1880), p. 9, f. 7; and Traité Zool., Prot. (1882), p. 52, f. 43; Gruber in Zeits. wiss. Zool. XXXVI, 1 (1881), p. 106, t. iv, f. 1; Hitchcock Synops. Freshw. Rhiz. (1881), p. 19; Taránek in Sitzber. böhm. Ges.

Wiss. 1881 (1882), p. 229; and in Abh. böhm. Ges. Wiss. (6) XI, 8, p. 46, t. iv, ff. 17–22; De Tarr in Rep. N. York State Mus. XXXV (1884), p. 167; Eyferth Naturgesch. mikr. Süsswass. ed. 2 (1885), p. 52, t. iii, f. 36; and ed. 3 (1900), p. 261, t. ix, f. 12; Imhof in Zool. Anzeig. VIII (1885), p. 162; Blochmann Mikr. Thierw. Süsswass. (1886), p. 12, t. i, f. 18; and ed. 2 (1895), p. 16, t. i, f. 14; Schneider in Sitzber. Akad. Wiss. Berlin, 1886, p. 895; Forel in Boll. Scient. III, an. 9 (1887), p. 90; Lang Lehrb. vergl. Anat. 1 (1888), f. 2 a (p. 4); ed. 2, Prot. (1901), f. 3 a (p. 7); and (Engl. transl.) Text-book Comp. Anat. 1 (1891), f. 2 a (p. 3); Penard in Mém. Soc. Genève, XXXI (1890), 2, p. 166, t. vii, ff. 40–55; in Jahrb. nassau. Ver. Naturk. XLIII (1890), p. 71; in Amer. Natur. XXV (1891), p. 1073; Faune Rhiz. Léman (1902), p. 376, ff. 1–3 (p. 377); and in Pr. R. Soc. Edinb. XXV, 8 (1905), pp. 595, 597; Gruber in Zacharias' Tierw. Süsswass. (1891), I, p. 141, f. 16 (7); Hertwig Lehrb. Zool. 1 (1891), f. 125 (p. 155); ed. 4 (1897), f. 123 (p. 162); and (Engl. transl.) Man. Zool. (1903), f. 128 (p. 196); Cash in Tr. Manch. Micr. Soc. 1891 (1892), p. 50; Daday in Termész. Füzetek, XV (1892), pp. 5, 170, etc.; Schewiakoff in Mém. Acad. Sci. St. Pétersb. (7) XLI (1893), 8, p. 98; Barrois in Mém. Soc. Sci. Lille (5) VI (1896), p. 118; Delage & Herouard Traité Zool. concr. I (1896), p. 105, f. 129; Frenzel Prot. in Bibl. Zool. IV, 12 (1897), p. 148: Schaudinn in Deutsch-Ost-Africa, IV, 2 (1897), 19, p. 8; André in Jahresb. nat. Ges. Graubünd. XLI (1898), p. 59; Averintzev in Trudui S.-Peterb. Obshch. XXX, 1 (1900), p. 239; *op. cit.* XXXVI (1906), 2, p. 231; Godet in Bull. Soc. Neuchâtel, XXVIII (1900), p. 77; Issel in Atti Soc. Ligustica, XII, 1 (1901), p. 59, t. i, f. 1; Lagerheim in Förh. Geol. Fören. Stockholm, XXIII (1901), p. 515 etc.; and *op. cit.* XXIV (1902), p. 349 etc., f. 12; Levander in Acta Soc. Fauna Fenn. XX (1901), 8, p. 12; G. S. West in Jrn. Linn. Soc., Zool. XXVIII (1901), p. 324; and in Ann. Scott. Nat. Hist. 1905, p. 99; Cushman in Amer. Natur. XL (1906), p. 373; Hartog Prot. in Cambr. Nat. Hist. I (1906), f. 10 a (p. 55); Schouteden in Ann. Biol. Lacustre, I, 3 (1906), p. 352, f. 26; Brehm in Arch. Hydrobiol. II, 4 (1907), p. 482; Hoogenraad in Tÿdschr. Nederl. Dierk. Ver. (2) X, 4 (1908), p. 410.

Quadrula simmetrica Longhi in Atti Soc. Ligustica, III (1892), p. 145.

Test in broad view pyriform, the crown semi-circular; much narrower at the mouth, which has a slightly convex outline; the sides tapering convexly downwards to the base; the structure compressed laterally. The transparent chitinous plates arranged in oblique series across the surface; usually smaller about the mouth than above, and not infrequently out of position. Plasma very clear, containing chlorophyl-corpuscles with other elements; the pseudopodia (usually 3–5) digitate; the single nucleus prominently situated in the upper region of the body.

Dimensions: Variable; average length about 96 μ; breadth 60–70 μ; in dorsal (transverse) view about 40 μ.

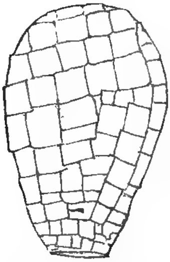

FIG. 102.—Test of *Quadrula symmetrica.* × 375.

In marshy ground amongst *Sphagnum*, etc.; sometimes in moss growing on moist rocks; abundant and widely distributed.

This beautifully-transparent species is usually abundant in boggy ground, where *Sphagnum* abounds. The disposition of the plates is not always symmetrical; they are sometimes seen pressed out of position, with, as a consequence, overlapping edges; frequently also the edges project beyond the margin of the test.

Two forms are found—sometimes in the same gathering—one considerably broader in proportion than the other, but not otherwise essentially differing.

Penard, in a paper communicated to the Royal Society of Edinburgh (March, 1905), "Sur les Sarcodinés du Loch Ness," mentions the variety *irregularis* first found by him in 1891 in *Sphagnum* from the Rocky Mountains, gathered at a height of 10,000 feet. In the Loch Ness gathering (1905) examples were found which might be referable to this variety. There is a doubt, however, as to whether it was not an abnormal form of typical *Q. symmetrica* derived from the adjacent *Sphagnum* bogs. No figure was published. *Q. symmetrica* var. *irregularis* is described in the 'American Naturalist,' December, 1891, p. 1073.

2. **Quadrula irregularis** Archer.

(Plate XXIX, figs. 4–9.)

Quadrula irregularis ARCHER in Q. Jrn. Micr. Sci. (n s.) XVII (1877), pp. 103, 113; and in Jrn. Dublin Micr. Club, III, 2 (1877), pp. 128, 231; G. S. WEST in Jrn. Linn. Soc., Zool. XXVIII (1901), p. 324, t. xxix, ff. 19, 20; PENARD in Arch. Protist. II (1903), p. 260, f. (p. 261); and in Rev. Suisse Zool. XIII, 3 (1905), p. 599, t. xiii, f. 15; AVERINTZEV in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 232; and in Zool. Anzeig. XXXI (1907), p. 244; SCHOUTEDEN (pars) in Ann. Biol. Lacustre, I, 3 (1906), pp. 352, 353; HOOGENRAAD in Tÿdschr. Nederl. Dierk. Ver. (2) X, 4 (1908), p. 410.

Quadrula monensis CASH in Tr. Manch. Micr. Soc. 1891 (1892), p. 50, t. ii, ff. 14–16.

Quadrula globulosa PENARD in Arch. Sci. nat. (3) XXVI (1891), p. 141, t. ii, f. 4; in Rev. Suisse Zool. VII, 1 (1899), p. 51, t. v, f. 6; and Faune Rhiz. Léman (1902), p. 380, ff. 1, 2 (p. 381); FOREL Le Léman, III (1904), p. 138.

Quadrula discoides PENARD in Arch. Sci. nat. (3), XXIX (1893), p. 178, t. ii, f. 20, 21; and Faune Rhiz. Léman (1902), p. 379, ff. 1–9; THIEBAUD in Zool. Anzeig. XXIX (1906), p. 796.

Quadrula subglobosa LAGERHEIM in Förh. Geol. Fören. Stockholm, XXIII (1901), p. 516, f. 6; and *op. cit.* XXIV (1902), p. 346, ff. 3, 4 (p. 350).

Quadrula irregularis var. *globulosa* PENARD in Arch. Protist. II, 2 (1903), p. 263; and Sarc. grands Lacs (1905), p. 42, 2 ff. (p. 43); LE ROUX in Ann. Biol. Lacustre, II, 1 (1907), p. 6.

Quadrula acolis Jaworowsky in Arch. Naturgesch. I (1905), 61, p. 320, t. xv, ff. 15–20.

Quadrula irregularis var. *globosa* Zschokke in Arch. Hydrobiol. II, 1 (1906), p. 6.

Very minute; in broad view compressed, and usually discoid, without any perceptible neck, and, as in the preceding species, composed of transparent chitinous membrane with a surfacing of square plates, obliquely arranged, mostly uniform in size and set in close order. In lateral view narrowly ovoid (but varying in the degree of compression), slightly notched at the mouth; dorsal and ventral views elliptic, the mouth either narrowly elliptic or presenting the appearance of a slit with parallel sides. Plasma colourless or faintly granular; a few minute yellowish-green corpuscles usually present, and a distinct contractile vacuole; the nucleus scarcely visible; the pseudopodia few, thin, flexible, transparent, and simple.

Dimensions: Longest diameter 30–38 μ.

Amongst *Sphagnum* in marshy ground; and in tufts of moss on wet rocks; much less common than the preceding. On a dripping canal wall at Neatley, Cheshire, 1891; Knutsford Moor, Cheshire. Penyghent, West Yorkshire (*G. S. West*). Perwick Bay, Isle of Man, 1891. Loch Ness, Scotland (*D. J. Scourfield*). Ireland, 1877 (*W. Archer*). Killough, Co. Wicklow, Ireland, 1908 (*J. Hopkinson*).

In the Isle of Man this organism occurred in abundance, in the locality mentioned, associated with various other rhizopods not usually found in such situations. A drop of water squeezed from a tuft of moss found growing in the crevices of rocks facing the sea, often contained a dozen or more individuals, besides empty tests. The latter exhibited the structure very clearly.

From *Q. symmetrica* the species differs both in size and form. The quadrangular plates are proportionately smaller on the smaller test, but they agree in the oblique arrangement. Only in var. *globulosa* Penard—a variety not as yet found in Britain—do they appear to be set in longitudinal series. The form of the test in this variety may account for the difference, for it is quite conceivable that a test approaching the spherical shape would more readily lend itself to a longitudinal arrangement of the surface-plates than one which is compressed. The variety referred to—var. *globulosa*—was discovered by Penard in the deep waters of the Lake of Geneva and in the Lakes of Lucerne and Constance.

In *Q. irregularis* a contractile vacuole may nearly always be detected, collapsing and dilating at intervals of about 45 seconds. The nucleus is small and not very distinct. The protoplasm is colourless. A few minute yellowish-green globules are always perceptible; but the whole organism is highly transparent, which circumstance, together with its small size and slowness of movement, renders it liable to be overlooked. As a rule, in the Cheshire and also in the Isle of Man examples the irregularity of the surface-plates, which suggested the specific name, does not often occur. The plates are as regular, certainly, as those of *Q. symmetrica*—on the whole probably more so. The species appears to be abundant where it occurs, but its distribution is more sporadic than that of the related species.

Penard has very carefully studied the forms of this species which have been described by himself and others under the varied names of *Q. monensis*, *Q. globosa*, *Q. globulosa*, and *Q. discoides*, and has come to the conclusion—in which we fully concur—that they should be included, as mere forms, under the common name of *Q. irregularis* Archer. They seem to differ from one another mainly in the disposition and size of the plates, their setting, and the degree of rotundity of the test. Penard also notes an interesting peculiarity in relation to the chemical composition of the test. Lagerheim, speaking of *Q. globulosa*, had (1901) pointed out that this was distinguished from all other freshwater rhizopods by the fact of the plates entering into the structure of the test being composed not of siliceous or chitinous material but of some combination of calcium. "After studying the works of Lagerheim," Penard says, "I myself experimented on various examples of *Quadrula* belonging to the forms *globulosa* (from Lake Geneva) and *discoides.* My procedure consisted in isolating an individual, and then, under the microscope, touching it with a minute drop of sulphuric acid. At the moment when the acid touched the shell this was seen to be instantaneously dissolved, but there remained a fine chitinous film which preserved the contour of the shell, and the outlines of the square plates. At the same time there was formed often a bubble of gas, which filled the shell; this most probably arose from the reaction of the acid on the shell contents, for in the case of clean and empty shells no such bubble was produced. If the shell thus acted upon were pushed forward, by lightly touching the cover-glass, the soft chitinous film would be folded in upon itself and become like a thread, showing no trace of any solid elements. If, on the other hand, it was exposed to the flame of a lamp for an instant, the film would dissolve completely in boiling acid, leaving no trace."

Lagerheim's experiments, the author concludes, establish the fact that the *Quadrula* test—whether *discoides*, *monensis*, or other—is covered with calcareous plates, or plates formed of a combination of calcium, placed side by side upon a very fine chitinous pellicle.

The examples from Knutsford Moor belonged to the form *discoides.* They were exceedingly abundant throughout the gathering, and were the smallest examples of the species we have met with, besides exhibiting great uniformity of structure.

The variability of *Q. irregularis* is indicated by a form of the var. *globulosa* described by Penard ('Archiv. für Protistenkunde,' 1903, p. 261)—occurring in a gathering from Spitzbergen—in which the minute test, whilst showing no compression, had a tendency to become ovate or sacciform, and irregular in contour, the circular oral aperture being situated at the extremity of a short and singularly unsymmetrical neck.

Genus 27. **HELEOPERA** Leidy, 1879.

Difflugia (*Nebela*) LEIDY in Pr. Acad. Philad. 1874, p. 157.
Nebela LEIDY in Pr. Acad. Philad. 1876, p. 119.
Heliopera LEIDY Freshw. Rhiz. N. Amer. (1879), p. 16.

Test chitinous, varying in colour from greyish-rose or deep purple, more or less convex at the mouth in broad view, or truncated, with rounded corners; the crown hemispherical and nearly always rough with adhering sand-grains, which in some individuals are piled up conically. The surface covered with transparent amorphous scales, the edges of which often overlap, and present a meshwork of fine but usually indistinct, dotted or interrupted lines. The mouth narrow, elliptic, notched in narrow lateral view. The plasma as in *Nebela* and *Hyalosphenia;* the nucleus single, situated posteriorly as in those genera; the pseudopodia variable in number, thin, digitate or branching.

1. **Heleopera sylvatica** Penard.

(Plate XXIX, figs. 10–12.)

Heleopera petricola LEIDY (pars) Freshw. Rhiz. N. Amer. (1879), p. 165, t. xxvi, ff. 16–19.
Heleopera sylvatica PENARD in Jahrb. nassau. Ver. Naturk. XLIII (1890), p. 71 ?; in Mém. Soc. Genève, XXXI (1890), 2, p. 168, t. vii, ff. 79–94; in Arch. Sci. nat. (4) VII (1899), p. 253; and Faune Rhiz. Léman (1902), p. 389, ff. 1–4 (p. 390); AVERINTZEV in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 255; SCHOUTEDEN in. Ann. Biol. Lacustre, I, 3 (1906), p. 357.

Test transparent, oval in broad view, compressed, narrower in proportion to its length than in the preceding species, and regular in contour, the sides curving evenly downwards to the distinctly convex mouth; its substance chitinous, covered externally with minute hyaline discs, or scales of no regular form, their edges showing as a faint reticulation; the crown smooth or capped with a few adhering sand-grains. The test in narrow lateral view compressed to about half the width, and narrowed anteriorly, the mouth forming a notch. Plasma, nucleus, and pseudopodia as in *H. petricola.*

Dimensions: Length 50–75 μ; breadth 25–30 μ.

In *Sphagnum*, not common. Dunham, Cheshire; Tan-y-Bwlch, N. Wales. Moel Siabod, N. Wales, at 2500 feet (*J. Hopkinson*).

This form, which we have in past years found in considerable abundance, at Dunham, corresponds in outline, and particularly in the structure of the mouth, with Penard's figure in 'Faune Rhiz. Léman.' That figure represents the test as covered with minute circular discs; ours have, in place of these, amorphous scales; and while the crown of the test is naked in the Swiss examples, ours are furnished—less abundantly, however, than in *H. petricola*—with a not very large allowance of sand-grains. It is curious to observe that, according to the author cited, this elegant species occurs in mosses of woods and hedge banks—"never in *Sphagnum*." Our examples are from *Sphagnum* solely. Some, especially those which are encysted, are beautifully transparent, and their elegance of form at once arrests attention.

2. **Heleopera petricola** Leidy.

(Plate XXIX, figs. 13–19.)

Heleopera petricola Leidy (pars) Freshw. Rhiz. N. Amer. (1879), p. 165, t. xxvi, ff. 12–15; in Pr. Acad. Philad. 1879, p. 162, and *op. cit.* 1880, pp. 335, 338; Hitchcock Synops. Freshw. Rhiz. (1881), p. 24; Taránek in Sitzber. böhm. Ges. Wiss. 1881 (1882), p. 232; and in Abh. böhm. Ges. Wiss. (6) XI (1882), 8, p. 42, t. iv, ff. 9–15; Blochmann Mikr. Thierw. Süsswass. (1886), p. 13, t. i, f. 27; and ed. 2 (1895), p. 17; Penard in Mém. Soc. Genève, XXXI (1890), 2, p. 167, t. vii, ff. 56–58; Faune

Rhiz. Léman (1902), p. 382, ff. 1–6; in Arch. Protist. II (1903), p. 257; in Pr. R. Soc. Edinb. XXV, 8 (1905), pp. 594, 596; and in Jrn. R. Micr. Soc. 1907, p. 277; CASH in Tr. Manch. Micr. Soc. 1891 (1892), p. 51, t. ii, ff. 19, 20, 30; LEVANDER in Acta Soc. Fauna Fenn. XII (1894), 2, p. 21; *op. cit.* XVIII (1900), 6, pp. 72, 77; and XX (1901), 8, pp. 8, 11; SCOURFIELD in Pr. Zool. Soc. 1897, p. 788; LAGERHEIM in Förh. Geol. Fören. Stockholm, XXIII (1901), p. 514 etc.; G. S. WEST in Jrn. Linn. Soc., Zool. XXVIII (1901), p. 323; and in Ann. Scott. Nat. Hist. 1905, p. 90; FOREL Le Léman, III (1904), p. 138; AVERINTZEV in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 256; CUSHMAN in Amer. Natur. XL (1906), p. 373; SCHOUTEDEN in Ann. Biol. Lacustre, I, 3 (1906), p. 357; ZSCHOKKE in Arch. Hydrobiol. II, 1 (1906), p. 4; LANDACRE in Pr. Ohio Acad. Sci. IV, 10 (1908), p. 429.

Test composed of chitinous membrane, strongly compressed, especially near the mouth, its surface covered with amorphous scales which form a loose reticulation and rarely present an appearance of regularity; the crown rough with sand-grains of varying size; the lateral margins straight or slightly convex; the mouth linear or elliptic, its edges thin, and, during the encystment of the organism, closed and sealed internally. Test subject to much variation, both in size and colour, individuals from one locality often differing considerably from those found elsewhere; but in all the mouth (in broad view) has a very modified convex outline, sometimes cut straight across, but more or less rounded at the corners. The plasma, in living individuals, not filling the cavity of the test. The nucleus generally conspicuous, in the upper region of the plasma; pseudopodia numerous and thin, with a tendency to bifurcate or throw out short lateral branches.

Dimensions: Length 80–100 μ.

In *Sphagnum*, in boggy places; most frequent in sub-alpine situations. Abundant in North Wales. Near Widdale Beck, N. Yorks; Hawkshead, Lancs; and near Glenties, Co. Donegal, Ireland (*G. S. West*).

Loch Ness (*D. J. Scourfield*), and Ben Ledi (*W. Evans*), Scotland. Killough and Calary Bog, Co. Wicklow, Ireland (*J. Hopkinson*).

The variation of *H. petricola* is remarkable, but though one might be tempted to differentiate the forms and say that certain of them represent distinct varieties, yet the fact that they merge into one another precludes such treatment. There is a small form very abundant in North Wales (represented by the figs. 13 and 14 on Plate XXIX) which seems to preserve its characters more than any other, but even this presents no special feature—unless it be in the matter of size—which would justify its separation from the type. Penard, in 'Faune Rhiz. Léman,' has some pertinent remarks on the variability of the species, and he points out a tendency (also noted by Scourfield in his paper on the rhizopodous fauna of Spitzbergen*) on the part of individuals to acquire a violet tint.

Var. **major,** *var. nov.* (Plate XXIX, figs. 20 and 21.)

Resembling the typical form of the species, but generally larger, and with a colourless or lightish grey test devoid of any purplish tint; the mouth slightly less convex, but narrowed, with the corners gracefully rounded off; the lateral margins from the crown downwards nearly straight. The nucleus normally situated, but obscured more or less with the granular and chlorophyllous contents of the plasma; one or more clear vesicles also present; the pseudopodia numerous, thin, aggregated about the mouth.

Dimensions: Length 120–125 μ.

In *Sphagnum*, and amongst aquatic mosses at pond sides; Dunham, Cheshire, and Padgate near Warrington.

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* 'Proceedings of the Zoological Society of London,' June, 1897, p. 788.

Var. **amethystea** Penard. (Plate XXIX, fig. 22.)

Heleopera petricola var. *amethystea* PENARD in Rev. Suisse Zool. VII, 1 (1899), p. 53, t. v, ff. 1–5; Faune Rhiz. Léman (1902), p. 384, ff. 7, 8 (p. 382); and Sarc. grands Lacs (1905), p. 36, 2 ff. (p. 37); AVERINTZEV in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 256; SCHOUTEDEN in Ann. Biol. Lacustre, I, 3 (1906), p. 357; MURRAY in Pr. R. Phys. Soc. (Edinb.) XVII, 4 (1908), p. 128.

Larger than the type, compressed laterally, oval-elongate, with an arched crown, the lateral margins straight or slightly convex, the oral extremity also convex, its corners rounded, the mouth thin-lipped, the lips yellowish and separated so as in narrow lateral view to form a notch. The chitinous test covered with comparatively-large thin plates or amorphous scales, which in places are irregularly imbricated; the whole structure deeply tinged with purple, or what may be described as a pure amethystine tint. The plasma (containing usually one or more contractile vacuoles) only partially filling the cavity of the test; nucleus normally situated; pseudopodia numerous, simple or branched.

Dimensions: Length 115–120 μ.

In *Sphagnum* and amongst aquatic mosses at pond sides; not infrequent, both in lowland and sub-alpine districts. Dunham, Cheshire; near Towyn, Llyn Idwal, and in the Sychnant Pass, N. Wales. Near Sutton Broad, Norfolk (*E. Gurney*). Epping Forest, Essex (*D. J. Scourfield*). Moel Siabod, N. Wales, at 2500 feet; Killough, Co. Wicklow, Ireland (*J. Hopkinson*). Aberfoyle, Scotland (*W. Evans*).

Penard separated this from the type on account of its possessing distinctive characters in regard to size and structure. The colour is a remarkably pure amethystine tint, which, it is thought, may probably be due to the presence of manganese. He remarks that the form may be distinguished from the type not only by the peculiarity of colour but also by its larger size and the comparatively-large imbricated scales which cover the entire surface of the test. His examples were obtained from the deep waters of Lake Léman, where one would expect these characters to be better developed than in the *Sphagnum* of a marsh; hence our British examples, which have been derived entirely from *Sphagnum*, seem, in comparison, much poorer. There is, however, no reason to doubt that they belong to the variety which Penard appropriately named *amethystea*. We find that the bright amethystine tint is not confined to the variety under consideration but is found also in *H. lata* sp. nov., to be described later.

3. **Heleopera rosea** Penard.

(Plate XXX, figs. 1 and 2.)

Heleopera rosea PENARD in Jahrb. nassau. Ver. Naturk. XLIII (1890), p. 71; in Mém. Soc. Genève, XXXI (1890), 2, p. 166, t. vii, ff. 59–78; Faune Rhiz. Léman (1902), p. 385, ff. 1–3 (p. 386); and in Pr. R. Soc. Edinb. XXV, 8 (1905), p. 59; LAGERHEIM in Förh. Geol. Fören. Stockholm, XXIII (1901), p. 514; AVERINTZEV in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 256; SCHOUTEDEN in Ann. Biol. Lacustre, I, 3 (1906), p. 357.

More robust and broader than *H. petricola* var. *amethystea*, and with a semi-circular crown which is sparingly dotted with sand-grains; the lateral margins, in the lower half, nearly straight down to the corners of the mouth; the outline of the latter, with its lips of thin yellowish chitine—their colour contrasting strongly with the vinous red of the body—evenly convex. The oral aperture, when directly presented to the eye, narrow, its outline lenticular or linear. The test, examined laterally, about one half the width of the broader surface. It is covered with amorphous scales, loosely arranged; and the walls are not too dense or deeply coloured, as a rule, to prevent the plasma and nucleus from being seen. The plasma not filling the entire cavity, but generally appearing as a compact mass, occupying the centre—the mass decreasing in width downwards—and widening out at the mouth; nucleus normally situated; pseudopodia thin and fairly numerous.

Dimensions: Length 120–135 μ, breadth at widest part 90–100 μ.

In *Sphagnum*, in sub-alpine districts, rare. Near Towyn, Merionethshire, 1905; the Sychnant Pass and Llyn Idwal, Carnarvonshire. Moel Siabod, N. Wales; Killough and Calary Bog, Co. Wicklow, Ireland (*J. Hopkinson*). Loch Ness (*D. J. Scourfield*); Aberfoyle and Ben Ledi (*W. Evans*), Scotland.

This species, though relatively large, is smaller than *H. sphagni* Leidy; but it is not likely to be confounded with that species, on account not merely of its vinous or rose-coloured test, but also of the character of the mouth, the corners of which, in perfect examples, are obtusely angular, with the lips yellow or lightish brown. Their edges are closely approximate; and in narrow lateral view the mouth is represented by a deep angular notch.

4. **Heleopera lata** *sp. nov.*

(Plate XXX, fig. 3.)

Test broadly ovoid, its vertical dimension exceeding but little the diameter in its broadest part (immediately below the crown); the crown forming a wide semicircle, and the lateral margins descending in straight lines downwards to the obtusely-angular corners of the mouth. The mouth proportionately broad; its outline slightly convex; and structurally resembling very closely that of the preceding species, the lips, which are thin and closely approximated, having a yellowish or lightish-brown margin, well defined. Colour of the test a deep vinous red, or purplish, and with a surfacing of amorphous scales, closely compacted, but not overlapping; the crown covered rather sparsely with variously-sized sand-grains. Plasma and pseudopodia not observed, but probably not differing from those of the preceding species.

Dimensions: Length 115 μ; breadth 100 μ; width of mouth 55 μ.

In *Sphagnum*, Knutsford, Cheshire; Criccieth, Carnarvonshire, and near Dolgoch Waterfall, Merionethshire. Killough, Co. Wicklow, Ireland (*J. Hopkinson*).

H. lata is a large and handsome species, and may readily be distinguished from its congeners by the broadly-arched crown and straight lateral margins. We have examined a good many tests and find these characters to be constant. In colour it closely resembles the preceding species, of which at first we took it to be a well-marked variety. Its frequent recurrence, however, in different localities, and slight tendency to vary, in any respect, justifies its receiving specific rank, though no living example has been met with.

5. **Heleopera sphagni** (Leidy).*

(Plate XXX, figs. 4–9.)

Difflugia (*Nebela*) *sphagni* LEIDY in Pr. Acad. Philad. 1874, p. 157.

Nebela sphagni LEIDY in Pr. Acad. Philad. 1876, p. 119, ff. 16, 17.

Heleopera picta LEIDY Freshw. Rhiz. N. Amer. (1879), p. 162, t. xxvi, f. 1–11; and in Pr. Acad. Philad. 1879, p. 163; HITCHCOCK Synops. Freshw. Rhiz. (1881), p. 24; ENTZ in Biol. Centralbl. II (1882), p. 451 (as *pieta*); DE TARR in Rep. N. York State Mus. XXXV (1884), p. 167; GREEFF ? in Sitzber. Ges. Nat. Marburg, 1888, p. 112; HARVEY in Amer. Natur. XXII (1888), p. 73 (as *pieta*); CERTES Prot. in Mission scient. Cap. Horn, VI, 3 (1889), p. 20; CASH in Tr. Manch. Micr. Soc. 1891 (1892), p. 51, f. 13; SCHEWIAKOFF in Mém. Acad. Sci. St. Pétersb. (7) XLI (1893), p. 98; FRENZEL in Bibl. Zool. IV, 12 (1897), p. 148; AVERINTZEV in Trudui S.-Peterb. Obshch. XXX, 1 (1900), p. 240; *op. cit.* XXXVI (1906), 2, p. 254; in Ber. Süsswass. nat. Ges. St. Petersb. I (1901), p. 215;

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* [*Heleopera picta* Leidy: CASH, MS. The remarks on p. 112 on change of specific name apply equally to this species.]

and in Zool. Anzeig. XXXI (1907), p. 310; G. S. West in Jrn. Linn. Soc., Zool. XXVIII (1901), p. 323; Schouteden in Ann. Biol. Lacustre, I, 3 (1906), p. 357; Landacre in Pr. Ohio Acad. Sci. IV, 10 (1908), p. 429.

Test large, broadly ovoid, strongly compressed, composed of chitinous membrane (yellowish or brownish-tinted) with a surfacing of amorphous transparent scales; the crown forming a broad semi-circle and rough with sand-grains, the lateral margins convex and carried with an unbroken outline round the slightly narrowed basal extremity; the mouth, consisting of a narrow slit, extending from side to side, its extremities taking in some examples an upward turn, so as, in narrow lateral view, to form an acute notch with the lips closely approximating. In transverse view (the crown being presented to the eye) the test is bi-convex. A considerable part of its cavity is unoccupied by the living organism. This in some individuals is concentrated in the upper half of the test, consisting of a round ball, with a distinct neck extending downwards to near the mouth where it widens out and occupies the extent of the narrowly-elliptic aperture, giving off generally a considerable group of thinnish and sometimes branching pseudopodia. In other examples (as in some gathered near Towyn) the plasma is connected with the internal walls of the test by prolongations of its own substance. It is not infrequently crowded with chlorophyllous pellets, clear vacuoles, and dense granular material, which more or less obscure the large nucleus; and a contractile vacuole may generally be detected in the anterior part of the endoplasm.

Dimensions: Length 145 μ; breadth 120 μ; across the mouth (in the Towyn examples), between the two extremities, 80 μ; breadth in dorsal view, 50 μ.

In *Sphagnum*, Knutsford Moor, Cheshire; in tufts of *Hypnum fluitans* from boggy ground at Dunham, Cheshire; also in similar situations on Irlam Moss, Lancashire; Llyn Idwal and near Towyn, N. Wales. Epping Forest, Essex (*D. J. Scourfield*).

The examples figured on Plate XXX show the extent of variation of this, the largest and most handsome of the Heleoperas, in widely-separated localities, one in the lowlands of Cheshire, the other a sub-alpine district in Merionethshire. The most striking variation, perhaps, is in the mouth. In both cases the lips are thin and closely approximated. So thin are they in the Cheshire examples that during encystment the outline of the mouth (in broad view) is lost and the chitinous membrane is thrown into folds and wrinkles. We have not seen any encysted example from Merionethshire, but in all living ones the mouth is clearly defined, and apparently of more solid substance, so that there is less likelihood of its presenting any modification under other conditions. In these, it will be observed from the figures that the broad convex base contrasts rather remarkably with the narrower and less convex mouth of the Cheshire examples. That figured (Pl. XXX, figs. 6–8) may be assumed to be a young individual; the test was very transparent, lightish yellow, with a reticulated surface, and a crown destitute of sand-grains; the animal was very active, the plasma crowded with bright green chlorophyllous matter, and the pseudopodia—flexible, sometimes bifurcated and contorted—were thicker than those from the Welsh locality. In narrow lateral view the test was narrowly ovoid, the mouth showing as an acute notch. When turned directly to the eye (in transverse section) the mouth presented the appearance of a narrow slit, with acute ends. Some empty tests were found, at Knutsford, a darkish purple in colour, with the ordinary surfacing combined with an admixture of quadrangular scales similar to those of *Quadrula symmetrica.*

The Merionethshire examples, besides exhibiting the peculiarities in broad view which we have pointed out, were more compressed, and in transverse section the ends of the ellipse were more narrowly obtuse, giving that section an outline which might almost be described as lenticular.

Genus 28. **LEPTOCHLAMYS** G. S. West, 1901.

Leptochlamys G. S. West in Jrn. Linn. Soc., Zool. XXVIII (1901), p. 325.

Test ovoid, slightly oblique, consisting of a thin, transparent, structureless, chitinoid membrane; the narrower or ventral end slightly produced and minutely expanded, terminating in a mouth which is often placed a little obliquely; circular in transverse view; mouth circular. Protoplasmic body completely filling the test; nucleus very large and situated dorsally. With a single short pseudopodium, broadly expanded and sometimes cordate. Vacuoles entirely absent.

1. **Leptochlamys ampullacea** G. S. West.

(Plate XXXI, fig. 19; and fig. 103 in text.)

Leptochlamys ampullacea G. S. West in Jrn. Linn. Soc., Zool. XXVIII (1901), p. 325, t. xxix, ff. 23–26; Averintzev in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 164; Schouteden in Ann. Biol. Lacustre, I, 3 (1906), p. 337.

Body composed of finely-granular protoplasm, containing a large punctate nucleus at the pole away from the mouth; both green and brown food-particles present in the body-protoplasm. With a single pseudopodium (sometimes a faint indication of two) well differentiated into a lobe of dull grey endoplasm enveloped in a larger mass of clear transparent ectoplasm.

Dimensions: Length of test 48–55 μ; diameter 36–40 μ; of mouth 15–17 μ.

Glyder Fawr, N. Wales (*G. S. West*).

Prof. G. S. West (whose description we quote) found this rhizopod among various algæ and *Isoëtes* in the shallow water at the margins of Llyn-y-cwm-ffynon, Glyder Fawr, N. Wales. The structureless test, he says, at first reminds one of *Hyalosphenia;* but, apart from the entirely different nature of the animal, it is at once distinguished from *Hyalosphenia* by its circular cross section and circular mouth. "It is a thin, transparent, chitinoid shell, generally somewhat obliquely ovoidal (or ellipsoidal), and possesses a slightly expanded, minutely bell-shaped mouth at the narrower or ventral pole. The shell is quite firm and rigid, and the body-protoplasm of the animal completely fills it, fitting closely to the inner surface. The nucleus, which, as compared with that of other lobose rhizopods, is exceedingly large, is situated towards the extreme dorsal pole of the shell, and exhibits a finely punctate appearance. The body-protoplasm is of a dull grey colour, and is filled with granules of variable magnitude, more especially in the region immediately ventral to the nucleus." * The single broad hyaline pseudopodium of this animal is a remarkable feature. "At most, it becomes retuse at the broad, distal end, and at all times there is a well-marked separation into ectoplasm and endoplasm." The author considers it closely related to *Cryptodifflugia* Penard. It differs from that genus in the character of the pseudopodia, *Cryptodifflugia* being figured by its author with pseudopodia which are very long and narrow.

FIG. 103.—*Leptochlamys ampullacea.* Lateral views of two examples, and oral view. Llyn-y-cwm-ffynon, N. Wales. From drawings by G. S. West. × 520.

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* [Evidently the region between the nucleus and the aperture.]

Genus 29. **COCHLIOPODIUM** Hertwig & Lesser, 1874.

Amœba (pars) Auerbach in Zeits. wiss. Zool. VII (1885), p. 374.
Amphizonella (pars) Greeff in Arch. mikr. Anat. II (1866), p. 328.
Cochliopodium Hertwig & Lesser in Arch. mikr. Anat. X (1874), Suppl. p. 66.

Test rudimentary, consisting of a thin, flexible, chitinous envelope, capable of expansion and contraction in response to the movements of the organism; multiform, and, as a rule, very minute; plain or covered with extremely fine hair-like processes; the plasma colourless, emitting variously-formed pseudopodia (blunt or pointed, but not acicular), in certain species visible in lobular or continuous expansions round the test, its finely drawn-out edges being jagged or serrated. Chlorophyllous particles sparingly occupying the finely-granular endoplasm, with, in some species, minute crystalline particles.

1. **Cochliopodium digitatum** (Greeff) Calkins.

(Plate XXXI, figs. 21–23.)

Amphizonella digitata Greeff in Arch. mikr. Anat. II (1866), p. 328, t. xviii, f. 18.
Amœba brevipes Greeff? in Arch. mikr. Anat. II (1866), p. 321, t. xviii, f. 17.
Amœba tentaculata Gruber in Zeits. wiss. Zool. XXXVI (1882), p. 460, t. xxx, ff. 1–8; Calkins Protozoa (1901), p. 38, f. 12 a (p. 39).
Cochliopodium digitatum Calkins Protozoa (1901), f. 13 b (p. 41); Penard Faune Rhiz. Léman (1902), p. 190, ff. 1–5 (p. 191); Averintzev in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 139; Schouteden in Ann. Biol. Lacustre, I, 3 (1906), pp. 331, 332, f. 2.

Body in the initial stage spherical or sub-spherical, covered with a fine transparent envelope; its changes of outline rapid and multiform; pseudopodia being produced on any or on all sides in the form of lobular expansions, or emitted from the blunt apices of short finger-like prolongations of the pliable envelope; being, in the latter case, short and acicular. The endoplasm slightly granular, containing a round nucleus, one or more contractile vacuoles, and a small number of minute chlorophyllous particles incepted as food.

Dimensions: In the initial stage 30–40 μ in diameter; in length, when in active motion, 60–80 μ.

In aquatic mosses from Dunham, Cheshire; March, 1905.

This curious organism is remarkable for its rapid changes of form during active life, appearing at one moment as an almost spherical globule of protoplasm, enclosed in a filmy envelope, and at the next as an actively moving body with several pseudopodia extending and retracting with great freedom from the summit of the blunt digitate processes which are thrust out generally in the direction of progression. Short lobular or digitate pseudopodia, consisting of clear ectoplasm, are also produced, usually from the posterior surface; these appear and disappear rapidly, as the movements of the animal are incessant.

2. **Cochliopodium bilimbosum** (Auerbach) Leidy.

(Plate XXXII, figs. 1–11.)

Amœba bilimbosa Auerbach in Zeits. wiss. Zool. VII (1856), p. 374, t. xix, ff. 1–16; Carpenter Foraminifera (*Ray Soc.* 1862), p. 23, t. i, f. 17; Carter in Ann. Nat. Hist. (3) XII (1863), pp. 32, 33.

Amphizonella vestita Archer (pars) in Q. Jrn. Micr. Sci. (n.s.) XI (1871), p. 112, t. vi, f. 3; Maggi in Boll. Scient. I, an. 2 (1880), p. 34.

Amœba zonalis Leidy in Pr. Acad. Philad. 1874, p. 87.

Cochliopodium pellucidum Hertwig & Lesser in Arch. mikr. Anat. X (1874), Suppl. p. 66, t. ii, f. 7; F. E. Schulze in Arch. mikr. Anat. XI, 2 (1875), p. 337, t. xix, ff. 1–5; Allman in Jrn. Linn. Soc., Zool. XIII (1877), p. 277, f. 6;

MAGGI in Rend. R. Ist. Lomb. (2) X (1877), p. 316; and in Boll. Scient. I, an. 2 (1880), p. 34; BÜTSCHLI in Bronn's Thier-Reichs, I, 1 (1880), t. ii, f. 11; KOROTNEFF in Arch. Zool. expér. VIII (1880), p. 480; LANESSAN Traité Zool., Prot. (1882), p. 52, f. 40; LANKESTER in Encycl. Brit. ed. 9 (1885), p. 842, f. iv, 8; LUDWIG in Leunis' Synops. Thierk. III, 2 (1886), p. 1171; PENARD in Jahrb. nassau. Ver. Naturk. XLII (1889), p. 144; FRENZEL in Arch. mikr. Anat. XXXVIII (1891), p. 12; LONGHI in Atti Soc. Ligustica, III (1892), p. 145; EYFERTH Naturgesch. mikr. Süsswass. ed. 3 (1900), p. 259; FAURE-FREMIET in Compt. Rend. Soc. biol. LVIII (1905), p. 905; DOFLEIN in Sitzber. Ges. Morph. Munchen, XXIII, 2 (1908), f. 6 (p. 124).

Cochliopodium bilimbosum LEIDY Freshw. Rhiz. N. Amer. (1879), p. 184; HITCHCOCK Synops. Freshw. Rhiz. (1881), p. 29; TARÁNEK in Sitzber. böhm. Ges. Wiss. 1881 (1882), p. 223; BLOCHMANN Mikr. Thierw. Süsswass. (1886), p. 11, t. i, f. 14; and ed. 2 (1895), p. 15, t. i, f. 10; WHITELEGGE in Pr. Linn. Soc. N. S. Wales (2) I (1887), p. 502; and in Jrn. R. Soc. N. S. Wales, XXIII, 2 (1889), p. 298; PENARD in Mém. Soc. Genève, XXXI (1890), 2, p. 133, t. iii, ff. 12–22; in Jahrb. nassau. Ver. Naturk. XLIII (1890), p. 70; and Faune Rhiz. Léman (1902), p. 184, ff. 1–5 (p. 185); FRENZEL in Arch. mikr. Anat. XXXVIII (1891), p. 12; and Prot. in Bibl. Zool. IV, 12 (1897), p. 148; CASH in Tr. Manch. Micr. Soc. 1891 (1892), p. 52, t. ii, f. 57; LEVANDER in Zool. Anzeig. XVII (1894), p. 209; in Acta Soc. Fauna Fenn. XII (1895), 2, p. 12; *op. cit.* XX (1901), 6, p. 5; and 8, p. 8; SCHAUDINN in Deutsch-Ost-Africa, IV, 2 (1897), 19, p. 6; AVERINTZEV in Trudui S.-Peterb. Obshch. XXX, 1 (1900), p. 239; *op. cit.* XXXVI (1906), 2, p. 138; in Zeits. angew. Mikr. V, 10 (1900), p. 270; and in Ber. Süsswass. nat. Ges. St. Petersb. I (1901), p. 210; PROWAZEK in Arb. zool. Inst. Wien, XII (1900), p. 243, t. i, f. 39; G. S. WEST in Jrn. Linn. Soc., Zool. XXVIII (1901), p. 312; ZACHARIAS in Forschb. biol. Stat. Plön, IX (1902), pp. 19, 21, t. i, ff. 8–10; ZYKOFF in Bull. Soc. Nat. Moscou, XVII (1903), p. 14; FOREL Le Léman, III (1904), p. 138; FAURÉ-FREMIET in Compt. Rend. Soc. biol. (Paris) LVIII (1905), p. 497; EDMONSTON in Proc. Davenport Acad. XI (1906), p. 19, t. v, f. 29; SCHOUTEDEN in Ann. Biol. Lacustre, I, 3 (1906), p. 331; HOOGENRAAD in Tÿdschr. Nederl. Dierk. Ver. (2) X, 4 (1908), p. 409.

Very minute; the test a transparent film of chitinous substance; the body of the organism, a greyish granular protoplasm, containing, with various refringent corpuscles and a little yellowish-green chlorophyllous matter, a comparatively large and round nucleus, and one or more contractile vacuoles. The pseudopodia delicate, pellucid, pointed or forked, never extending far beyond the margin, sometimes replaced by expansions of colourless ectoplasm, which may be visible on all sides with a continuous or broken margin, or on one side only.

Dimensions: Variable; diameter of test, 32–44 μ (*West*).

In still waters upon submerged vegetation, or on the surface-ooze of the bottom. In ponds at Baguley and Northenden, Cheshire. Near Brigg, Lincolnshire; Llyn Ogwen and Capel Curig, North Wales; near Lough Neagh and Co. Donegal, Ireland; and the Hebrides (*G. S. West*). Loch Ness, Scotland (*D. J. Scourfield*).

The test of *C. bilimbosum*, under a power of about 600 diameters, is delicately punctated. In lateral outline it appears widely bell-shaped but this is susceptible of change; its margin is defined by a doubly-contoured dotted line; it is more translucent near the mouth. The margin of the expanded protoplasm is more or less delicately serrulate under a high magnification. Leidy found this organism very common near Philadelphia in the waters of ditches and ponds, amongst algæ and other low vegetation, but from its minute size and tranparency he said that it was very liable to be overlooked or mistaken for an *Amœba*. A little examination, however, reveals the presence of the flexible transparent envelope, the outer margin of which is often exceeded by the expanded endoplasm, and from this the usually pointed, short pseudopodia are emitted. The living organism is closely invested with its envelope, and the finely punctated surface of the latter can only be demonstrated, as Leidy remarks, by careful illumination and the employment of a tolerably high power.

3. **Cochliopodium minutum** G. S. West.

(Plate XXXII, figs. 12–14; and fig. 104 in text.)

Cochliopodium minutum G. S. West in Jrn. Linn. Soc., Zool. XXVIII (1901), p. 312, t. xxviii, ff. 6–10 (; *cf.* Averintzev in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 141).

Very minute, with a cup-shaped delicate test having a very wide mouth. Body-protoplasm granular; pseudopodia somewhat irregular, usually attenuated anteriorly. Nucleus absent. One or two vacuoles present in some individuals, but entirely absent in others.

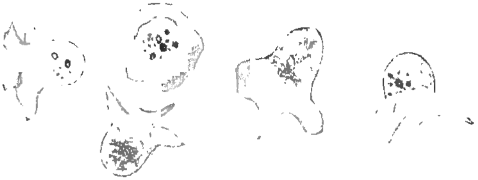

Fig. 104.—Various phases of *Cochliopodium minutum*. Llyn-y-cwm-ffynon, N. Wales. From drawings by G. S. West. × 520.

Diameter of test 12·4–13·5 μ (*West*).

Llyn-y-cwm-ffynon, N. Wales; April, 1900 (*G. S. West*).

Prof. G. S. West (whose description we quote) records the finding of this species in abundance amongst desmids, in washings of *Isoëtes* from Llyn-y-cwm-ffynon, N. Wales. The test is structureless, very delicate, and flexible, and assumes various unsymmetrical shapes as it accommodates itself to the animal's movements. Seen from above the test is usually circular, but it frequently exhibits an irregularly undulate margin. The pseudopodia consist commonly of somewhat flattened extensions of colourless ectoplasm, with distinctly attenuated ends. They are "colourless hyaline projections showing no trace of any granulation." When the animal is active the pseudopodia are extended and retracted with considerable rapidity of movement. Its minute size, the absence of nucleus, and the pellucid, plain, and delicate test distinguish it from the preceding species.

4. **Cochliopodium vestitum** Archer.

(Plate XXXII, figs. 15–18.)

Amphizonella vestita Archer (pars) in Q. Jrn. Micr. Sci. (n.s.) XI (1871), pp. 112, 135, t. vi, ff. 1, 2, 4–6.

Cochliopodium pilosum Hertwig & Lesser in Arch. mikr. Anat. X (1874), Suppl. p. 78.

Cochliopodium vestitum Archer (pars) in Q. Jrn. Micr. Sci. (n.s.) XVII (1877), p. 334; Leidy (pars) Freshw. Rhiz. N. Amer. (1879), p. 188, t. xxxii, f. 26; Hitchcock Synops. Freshw. Rhiz. (1881), p. 30; Greeff in Sitzber. Ges. Nat. Marburg, 1888, p. 155; Blochmann Mikr. Thierw. Süsswass. ed. 2 (1895), p. 15; Frenzel Prot. in Bibl. Zool. IV, 12 (1897), p. 148; Averintzev in Trudui S.-Peterb. Obshch. XXXI, 1 (1900), p. 239; *op. cit.* XXXVI (1906), 2, p. 136; and in Ber. Süsswass. nat. Ges. St. Petersb. I (1901), p. 211; G. S. West in Jrn. Linn. Soc., Zool. XXVIII (1901), p. 313; Penard Faune Rhiz. Léman (1902), p. 198, ff. 1–5 (p. 199); Schouteden in Ann. Biol. Lacustre, I, 3 (1906), pp. 330, 331, f. 1; Hoogenraad in Tÿdschr. Nederl. Dierk. Ver. (2) X, 4 (1908), p. 410.

In general character resembling *C. bilimbosum* Leidy, and of the same average dimensions, normally rotund, but susceptible of variation, especially in the anterior portion, where the envelope is very supple.

Body nearly colourless or bluish, varied (says Archer) by a pale brownish hue, "enclosing a number of minute clear shining purplish-grey generally elliptic, sharply-bounded corpuscles; these forming a stratum just under the periphery of the body below which often occurs a more or less dense stratum of large bright chlorophyl-granules." The pseudopodia hyaline, generally emanating in a cluster from the anterior region; short and conical or elongated, tapering, and bluntly pointed. The thin investing membrane covered superficially with fine hair-like processes which give the organism a finely hirsute appearance.

Dimensions: Average 35 μ (*Penard*). Diameter without spines 24–25 μ; length of spines 3·7–5 μ (*West*).

In ponds and ditches, chiefly amongst floating algæ, rare. Esher West End Common, Surrey, and near Cambridge (*G. S. West*). Ponds at Northern Etchells, Cheshire. Co. Westmeath, Ireland (*W. Archer*).

Archer was of opinion that this was identical with *C. bilimbosum*. Leidy, however, whilst admitting that there might be good ground for the supposition, kept the two forms distinct. The Cheshire examples were sufficiently characteristic, and could not possibly be confounded with *C. bilimbosum* from the same neighbourhood. The colour of the test Archer found varied from a pale yellowish brown in some examples to a pale bluish tint in others, the deeper colour being always at the circumference of the body. The movements of the animal are extremely slow.

The organism which we have figured (Pl. XXXII, figs. 17 and 18), obtained from *Sphagnum* gathered near Towyn, Merionethshire, might almost be considered a new species. It was smaller and much more delicate than typical *C. vestitum*, whilst agreeing with this species in having an almost invisible array of fine hair-like processes covering the surface. Seen in lateral view the form of the test was bell-shaped, with a perceptible expansion at the mouth. There was a further peculiarity in the character of the ectoplasm. Instead of the straight pointed pseudopodia so characteristically grouped in *C. vestitum*, these organs were represented by a broad expansion of colourless ectoplasm, very finely serrated on the outer margin, but without lobes or prolongations of any kind. The body of the organism was well filled with minute chlorophyllous particles and fine granular matter, and the nucleus was conspicuous, in the posterior region, a little way removed from the centre.

5. **Cochliopodium echinatum** Korotneff.*

(Plate XXXII, fig. 19.)

Cochliopodium echinatum Korotneff in Arch. Zool. expér. VIII (1879), p. 480, t. xxxv, f. 9; Penard Faune Rhiz. Léman (1902), p. 196, ff. 1–6 (p. 197); Averintzev in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 136; Schouteden in Ann. Biol. Lacustre, I, 3 (1906), p. 331.

Cochliopodium vestitum Leidy (? pars) Freshw. Rhiz. N. Amer. (1879), p. 138, t. xxxii, ff. 27, 28.

Cochliopodium longispinum G. S. West in Jrn. Linn. Soc., Zool. XXXVIII (1901), p. 313, t. xxviii, f. 1; Penard in Rev. Suisse Zool. XIII, 3 (1905), p. 595, t. xiii, f. 11.

Test very thin and delicate, subspherical, with a broadly-open somewhat prominent mouth; its exterior covered with very long extremely delicate hair-like radiating spines. Body-protoplasm granular, and containing many highly refractive globules. Nucleus large and round, situated near the fundus, with one, sometimes more, contractile vacuoles. Pseudopodia few, broad and expansive, granular in the central part, but hyaline and indistinct towards the edges.

Dimensions: Diameter of test 42 μ; of mouth 34 μ; length of spines 23–39 μ (*West*).

Amongst *Chara hispida*, Wicken Fen, Cambridgeshire; July, 1899 (*G. S. West*).

This species differs from *C. vestitum* not only in the possession of longer spines but also in the wider mouth and more lobose pseudopodia. The spines, says Prof. West (whose description we have quoted), are more numerous than those of *C. vestitum*, and the mouth is comparatively broader than in that species. The pseudopodia are also thicker and more expansive, and the refractive globules from the body of the animal often pass into them. The examples found were destitute of green colouring matter.

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* [*Cochliopodium longispinum* West: Cash, MS.]

Genus 30. **AMPHIZONELLA** Greeff, 1866.

Corycia Dujardin? in Ann. Sci. nat., Zool. (3) XVIII (1852), p. 241.
Amphizonella Greeff in Arch. mikr. Anat. II (1866), p. 323.

Envelope membranous, thin and supple near the mouth, presenting a double marginal contour, the inner—representing the periphery of the envelope—smooth and well defined; the outer much finer, and serrulate; the plasma dense and uninuclear; the pseudopodia blunt, digitate, radiating in a greater or less degree from the inverted mouth.

1. **Amphizonella violacea** Greeff.

(Plate XXXI, fig. 20.)

Amphizonella violacea Greeff in Arch. mikr. Anat. II (1866), p. 323, t. xviii, ff. 12–15; and in Sitzber. Ges. Nat. Marburg, 1888, p. 98; Archer in Q. Jrn. Micr. Sci. (n.s.) XVII (1877), p. 464; Leidy? Freshw. Rhiz. N. Amer. (1879), p. 291; Blochmann Mikr. Thierw. Süsswass. (1886), p. 11, t. i, f. 12; and ed. 2 (1895), p. 14, t. i, f. 8; Maggi in Arch. Ital. Biol. X (1888), pp. 185, 189; Penard in Mém. Soc. Genève, XXXI (1890), 2, p. 132, t. iii, ff. 9–11; Faune Rhiz. Léman (1902), p. 166, ff. 1–4 (p. 167); and in Rev. Suisse Zool. XIV, 2 (1906), p. 110, t. iv, ff. 1–3; Prowazek in Arb. zool. Inst. Wien, XII, 3 (1900), p. 14.

Test patelliform, round in lateral view, and susceptible of little change except at the mouth where the membrane is thinnest; violet-tinted; the fine outer margin delicately serrulate, enveloping the test and about equidistant from it (merging into it only on each side of the mouth); the plasma dense, granular, containing besides chlorophyllous corpuscles and granular matter, a varying number of clear vacuoles and a single round nucleus. The pseudopodia straight, blunt, digitate, and extending radially from the orifice. Movements of the organism habitually sluggish.

Dimensions: Average diameter 160 μ (*Penard*).

Ireland, 1877 (*W. Archer*).

This organism, since Greeff's description of it was first published in Schulz's *Archiv*, has been the subject of much controversy, some authors maintaining that it properly belongs to the genus *Cochliopodium* Hertw. & Less., whilst others have confounded it with the more recently discovered *Zonomyxa violacea* Nüsslin.

As Greeff pointed out, the outer envelope of *A. violacea* is of a character which renders it liable to be mistaken for a band of hyaline ectosarc, but upon close examination it will be found to represent an independent structure carried round the lateral margin of the test and organically connected with it. Its differentiation from the protoplasmic substance has been demonstrated by the use of reagents. The violet tint is said to be very evanescent; it readily disappears under the action of acids.

Penard in "Notes sur quelques Sarcodinés," in 'Rev. Suisse de Zool.' (1906), makes an exhaustive comparison of the two organisms, *Amphizonella violacea* Greeff, and *Zonomyxa violacea* Nüsslin, and establishes their mutual independence. Not the least important difference between them—apart from the difference of contour—is the uninuclear character of the one and the multinuclear character of the other.

Genus 31. **ZONOMYXA** Nüsslin, 1882.

Zonomyxa Nüsslin in Zeits. wiss. Zool. XL, 4 (1882), p. 697.

Body roundish pyriform, invested by a supple chitinoid membrane (without the clear mucilaginous envelope characteristic of the preceding genus), violet-coloured; plasma granular, with numerous clear vacuoles and chlorophyllous particles; pseudopodia simple, not digitate; nuclei several.

1. **Zonomyxa violacea** Nüsslin.

(Plate XXXII, figs. 20 and 21.)

Zonomyxa violacea NÜSSLIN in Zeits. wiss. Zool. XL, 4 (1882), p. 697, t. xxxv, ff. 1–23; and in Jrn. R. Micr. Soc. (2) IV (1884), p. 908; PENARD in Rev. Suisse Zool. XIV, 2 (1906), p. 115, t. iv, ff. 4–7.

Body relatively large; its initial form more or less discoid, changing to pyriform when in motion, broad posteriorly, then narrowing convexly, but with a more or less uneven outline to the anterior extremity, from which, through a narrow slit in the membranous envelope, a single lobe of ectoplasm is emitted. This pseudopodium is colourless, simple, without any tendency to branch or become digitate, and has an acuminate point. Body of the test violet-tinted, protected by a transparent or yellowish chitinoid membrane, which, being flexible, adapts itself to the changes of form assumed by the living animal during progression. The membrane anteriorly is fine and extensible, yielding readily to pressure from within. Several nuclei—as many as four—may be detected in the granular endoplasm, and also numerous vacuoles.

Dimensions: Diameter, in a state of repose, 140–160 μ; length when extended or in active motion 250 μ or more (*Penard*).

Detected by Dr. Penard in a gathering of *Sphagnum* sent to him from Midlothian by Mr. W. Evans, 1906. Not reported from any other part of Britain.

We have no personal acquaintance with this apparently very distinct organism, which in this country seems to be extremely rare. It is clear from Dr. Penard's exhaustive description in 'Rev. Suisse de Zool.,' that, since Nüsslin's discovery in 1882, authors have been too hasty in assuming its identity with *Amphizonella*. It is met with in *Sphagnum*, whilst *A. violacea* affects more the aquatic mosses of the margins of ponds.

The envelope has no visible orifice, as the author cited points out; it is exceedingly thin at the anterior extremity, and the converging lips are thrust apart by the lobe of ectoplasm which forms the single pseudopodium, the limit of the membranous envelope being indicated, as it emerges, by a fine transverse line.

The pyriform body, when the organism is active, the simple envelope, and the multinuclear plasma, sufficiently distinguish this species from *Amphizonella violacea* Greeff.

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§ B. *DIFFLUGIÑA.*

[(p. 48) 18 a. **Difflugia tuberculata** (Wallich) Archer.

(Figs. 105 and 106.)

Difflugia proteiformis sub-sp. *globularis* var. *tuberculata* WALLICH in Ann. Nat. Hist. (3) XIII (1864), p. 241, t. xv, f. 4*g*; t. xvi, f. 18.

Difflugia tuberculata ARCHER in Q. Jrn. Micr. Sci. (n.s.) VII (1867), p. 177; and in Jrn. Dublin Micr. Club, I, 2 (1867), p. 121; AVERINTZEV in Ber. Süsswass. nat. Ges. St. Petersb. I (1901), p. 212, t. iv, ff. 19, 20; and in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 182; PENARD Faune Rhiz. Léman (1902), p. 291, ff. 1–6 (p. 292); SCHOUTEDEN in Ann. Biol. Lacustre, I, 3 (1906), pp. 341, 345.

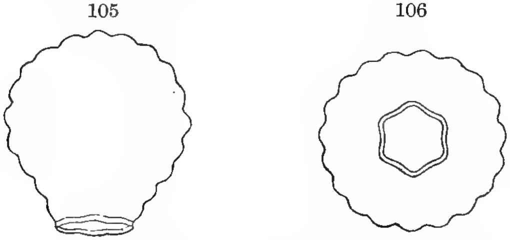
Difflugia lobostoma LEIDY (pars) Freshw. Rhiz. N. Amer. (1879), p. 115, t. vi, ff. 21, 22; VERWORN in Zeits. wiss. Zool. L, 2 (1890), p. 443, t. xviii.

Difflugia lobostoma var. *tuberculata* MINKIEWICZ in Zool. Anzeig. XXIII (1900), p. 620.

Test ovoid laterally, in transverse section circular, mamillated throughout with subhemispherical elevations exteriorly and corresponding depressions interiorly, the surface having a mulberry-shaped appearance sometimes masked by the sand-grains of irregular size with which it is covered; the crown spherical, the sides tapering with a convex curve to the aperture which is about one-third the diameter of the test, has a narrow lip or collar, and is hexagonal with sinuous lobes. Plasma occupying about two-thirds the cavity of the test, to which it is attached by numerous slender filaments; usually with a single large contractile vesicle; nucleus delicate, with numerous nearly circular nucleoli of unequal size; pseudopodia normal.

Dimensions: Average diameter 130 μ (*Penard*).

Ireland, 1867 (*W. Archer*).



FIGS. 105 AND 106.—*Difflugia tuberculata*: 105, lateral view; 106, oral view. Outlines derived from Wallich's and Penard's figures. × 200.

As in the case of several other rhizopods which Archer found in Ireland and exhibited before the Dublin Microscopical Club, he omitted to give the locality. That the species does occur in Ireland has recently been confirmed by Dr. Penard.

Wallich described *Difflugia tuberculata*, as of varietal rank only, in the 'Annals of Natural History' for March, 1867, without giving any locality for it, and in that magazine for the previous January a very similar form from Bombay was described by Carter under the name of *Difflugia bombayensis*. This is usually considered to be the same species, but was stated by him to have an even aperture which also appears to be without a lip and smaller than that of *D. tuberculata*, the test not being truncated for it.

Archer's record has only recently been noticed.]

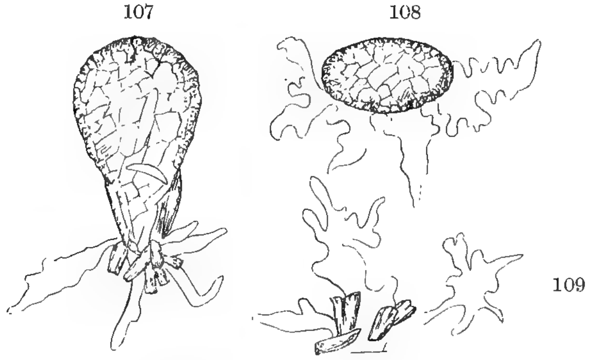
[(p. 64) 4. **Pontigulasia elisa** (Penard) Schouteden.

(Figs. 107–109.)

Difflugia elisa Penard in Arch. Sci. nat. (3) XXIX (1893), p. 177, t. iii, f. 7.

Pontigulasia incisa Rhumbler in Zeits. wiss. Zool. LXI, 1 (1895), p. 105, t. iv, ff. 5, 22–25; Penard Faune Rhiz. Léman (1902), p. 315, ff. 1–6; Averintzev in Trudui S.-Peterb. Obshch. XXXVI (1906), 2, p. 169.

Pontigulasia elisa Schouteden in Ann. Biol. Lacustre I, 3 (1906), p. 345 (note).



Figs. 107–109.—*Pontigulasia elisa*: 107, lateral view; 108, dorsal view; 109, pseudopodia with sand-grains embedded. After Rhumbler (*loc. cit.*). × 200.

Test pyriform laterally, in transverse section oval but becoming more nearly circular towards the aperture; covered with sand-grains, diatoms, etc.; the constriction, about two-thirds from the crown, marked externally by a deep notch extending about half way across it in broad view, being the line of attachment of each end of the diaphragm, which extends, narrowing towards the centre, across the constriction bisecting the opening through which the pseudopodia pass. Plasma normal, occupying about half the cavity of the test; nucleus with numerous circular nucleoli of nearly equal size; pseudopodia palmate, very irregular in outline, sometimes much expanded and bearing close to the aperture several sand-grains or other adventitious matter.

Dimensions: Length 85–150 μ; breadth, in broad view rather more than half the length, in narrow view about one-third the length.

In *Sphagnum*-pool, Killough, Co. Wicklow, Ireland; September, 1908 (*J. Hopkinson*).

This peculiar rhizopod was detected by Mr. Cash in *Sphagnum* from a small pool on the Great Sugar Loaf Mountain, Co. Wicklow, and appears (as *Pontigulasia incisa*) in his list of species from that locality, but it is not in his MS. of this work nor had he written a description of it. It is therefore with some hesitation that it is added here, but the species is so distinct from any other *Pontigulasia* that he can scarcely have been mistaken in his identification.

Originally described by Penard as a *Difflugia*, it was described by Rhumbler under a different specific name when he gave generic rank to the group of species possessing a diaphragm. Not only must that name (*incisa*) fall, but his *P. compressa* also, being preoccupied by Carter's species described on p. 62. Rhumbler's *P. compressa* (which might now be called *P. Rhumbleri*) is the only known *Pontigulasia* besides *P. elisa* with the diaphragm forming a similarly-shaped bridge across the test, but the test of that species is much broader in proportion to its length and is not perceptibly constricted at the diaphragm.]

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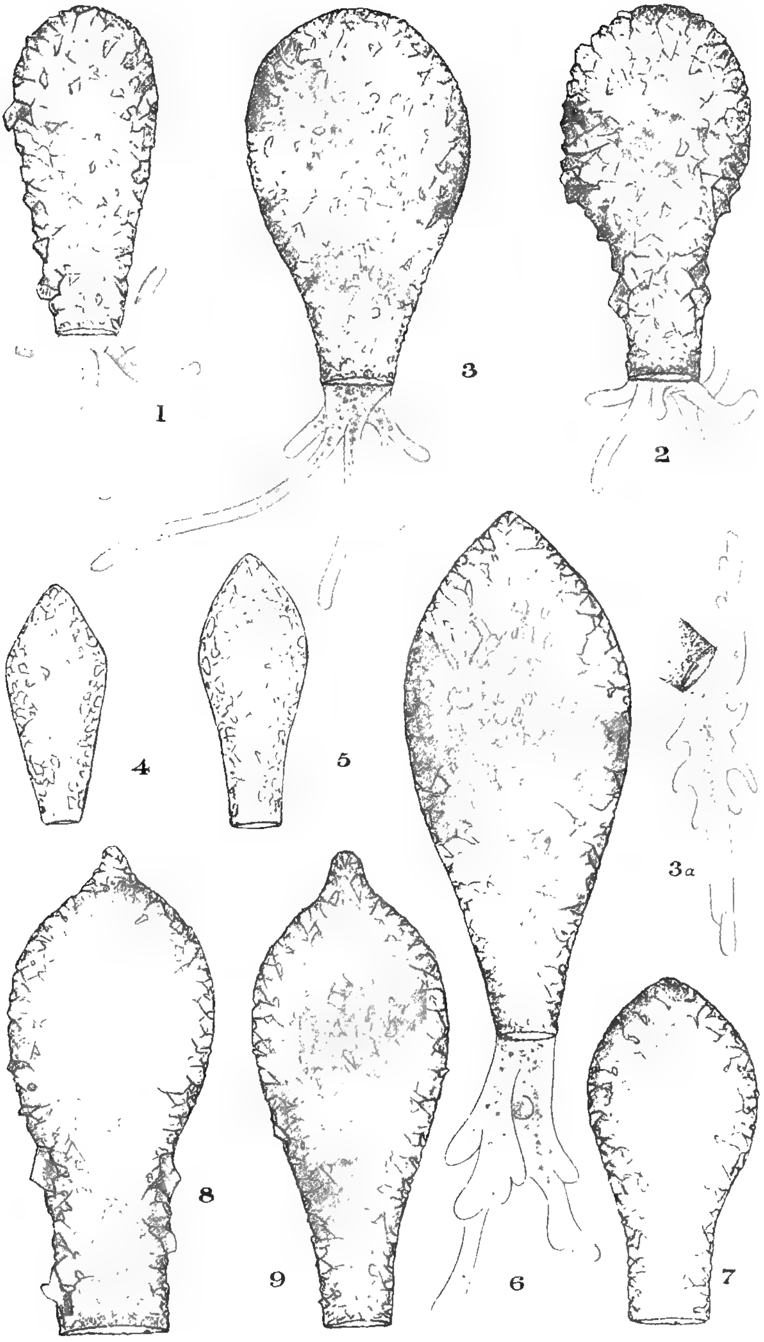

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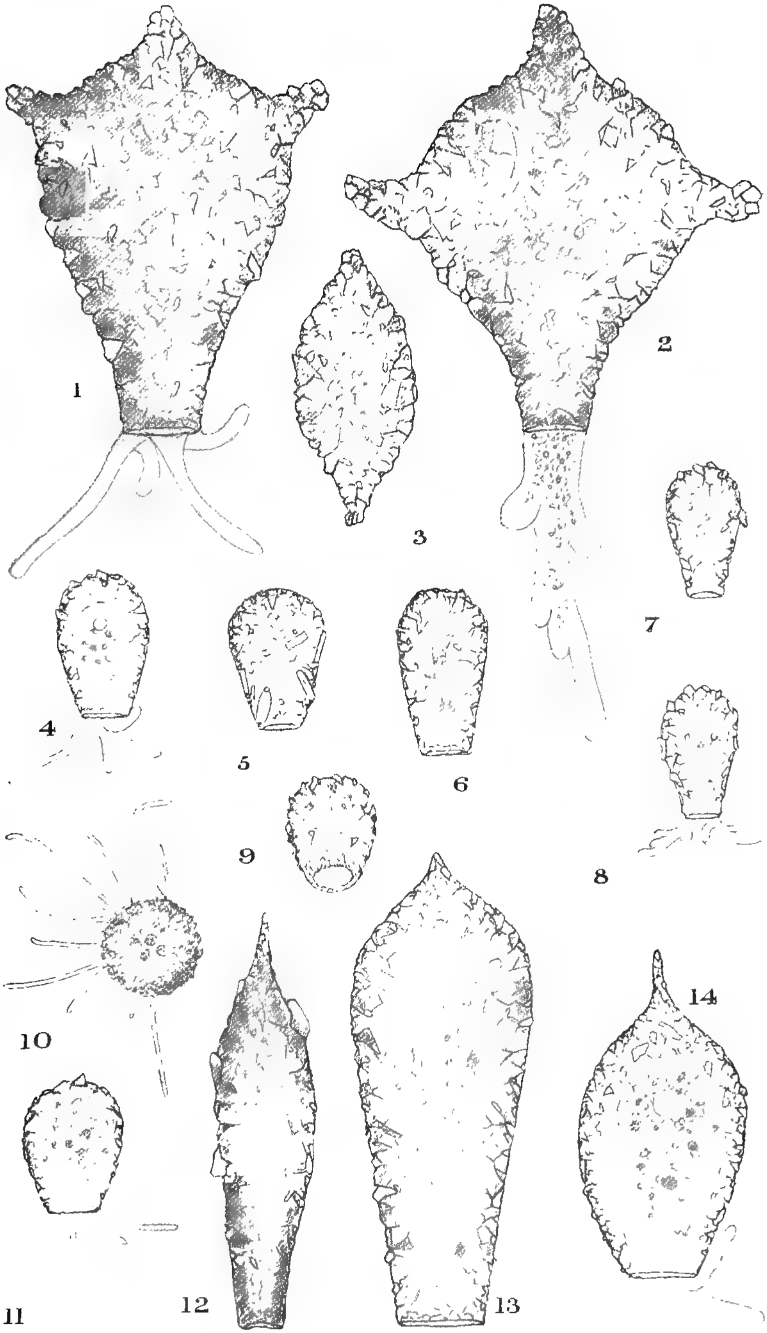

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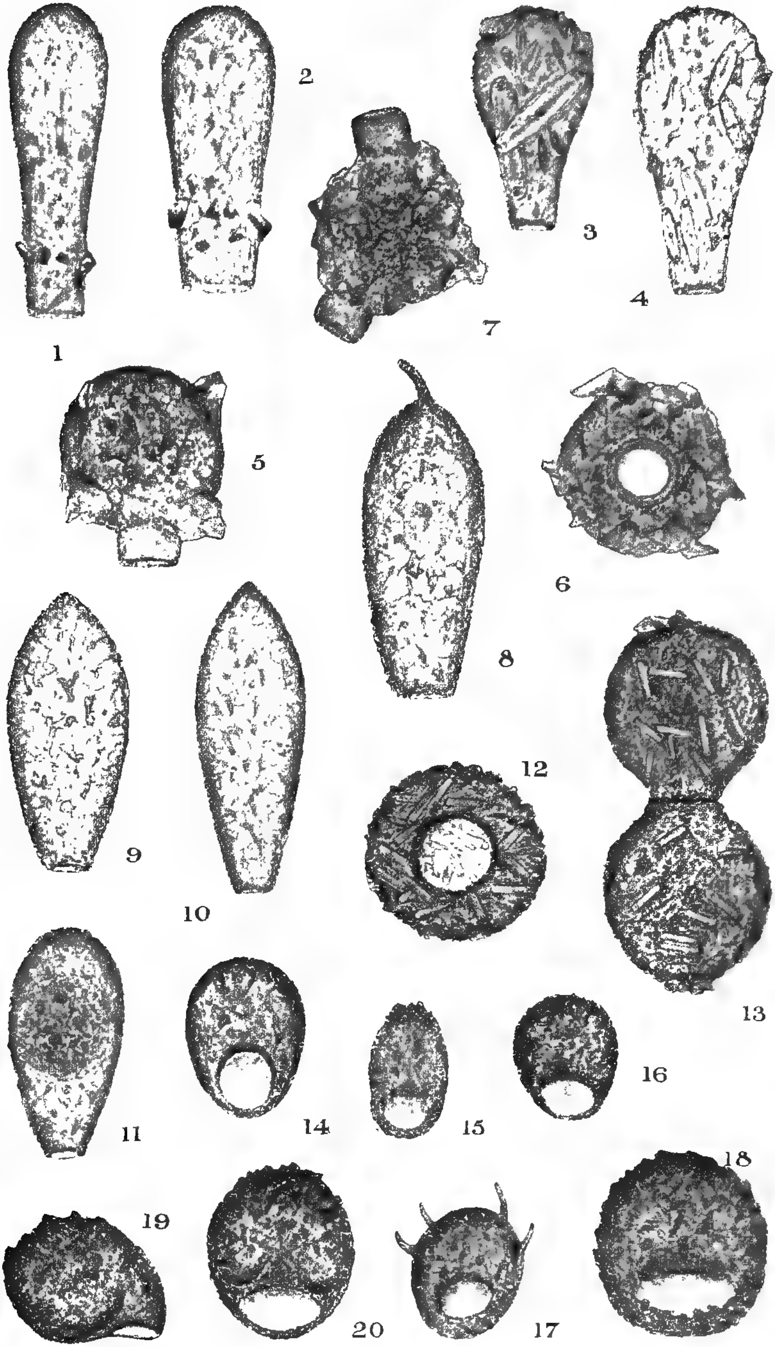

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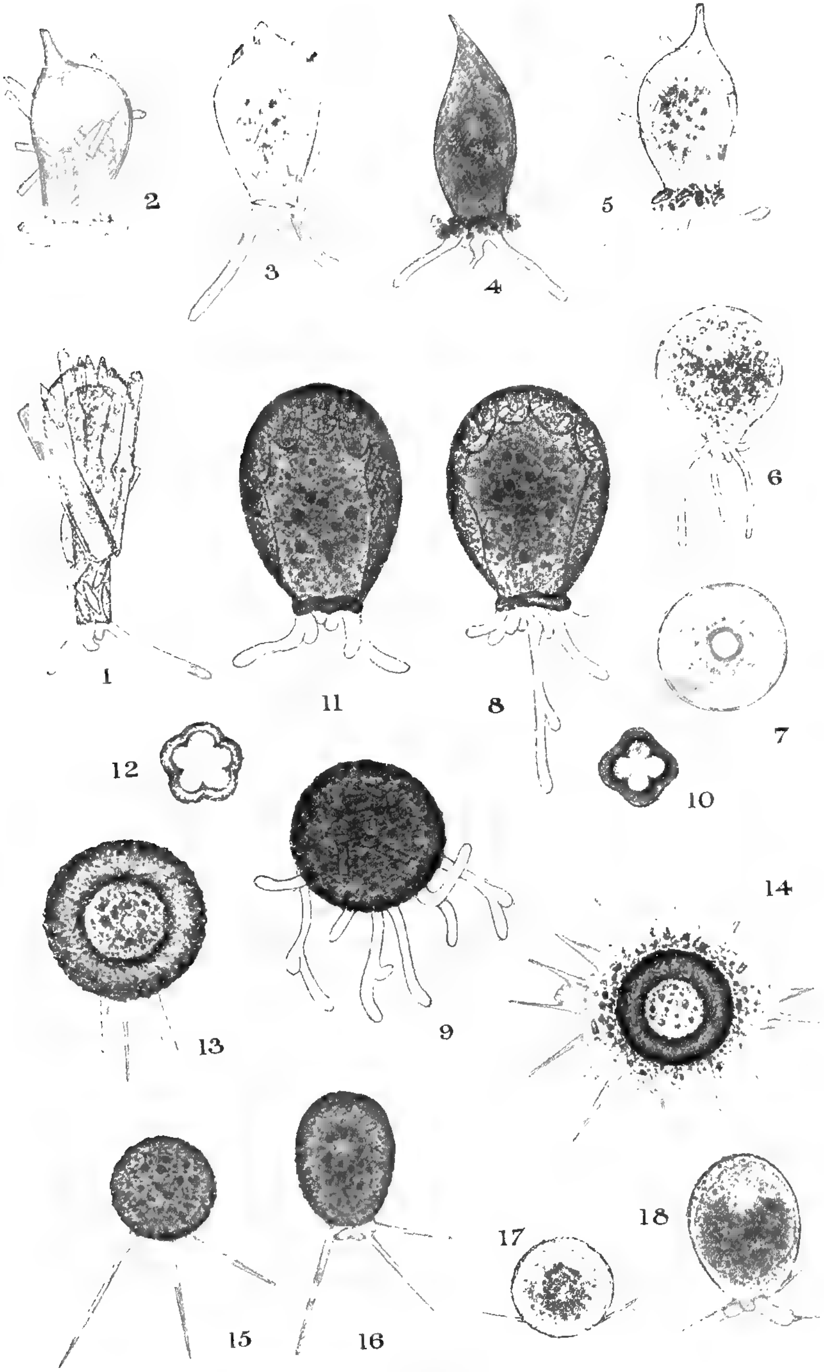

[illegible] A, AND DIFFLUGIELLA.

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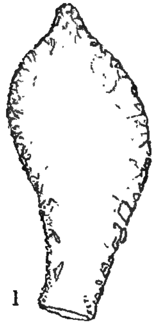
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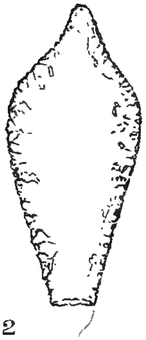
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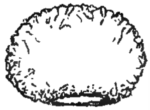
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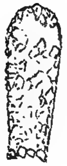
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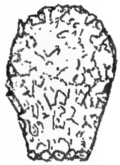
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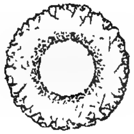
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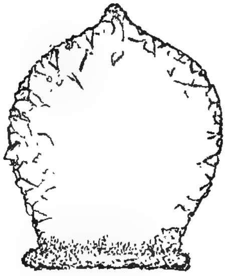
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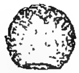
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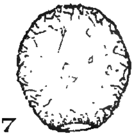
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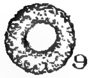
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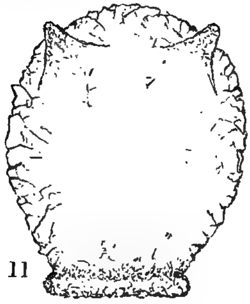
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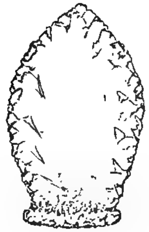
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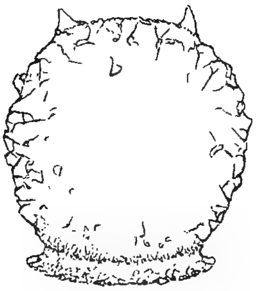
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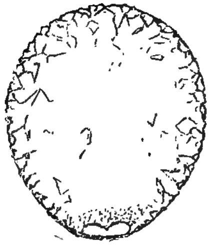
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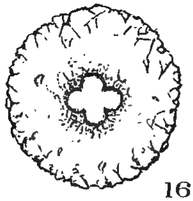
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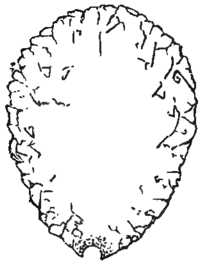
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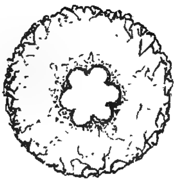
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GIA.

Plate 22

PLATE XXII.

Figs.

1, 2. *Difflugia gramen* Penard. (p. 48) Lateral and oral views of a living example. In *Sphagnum* from Criccieth, N. Wales. × 280.

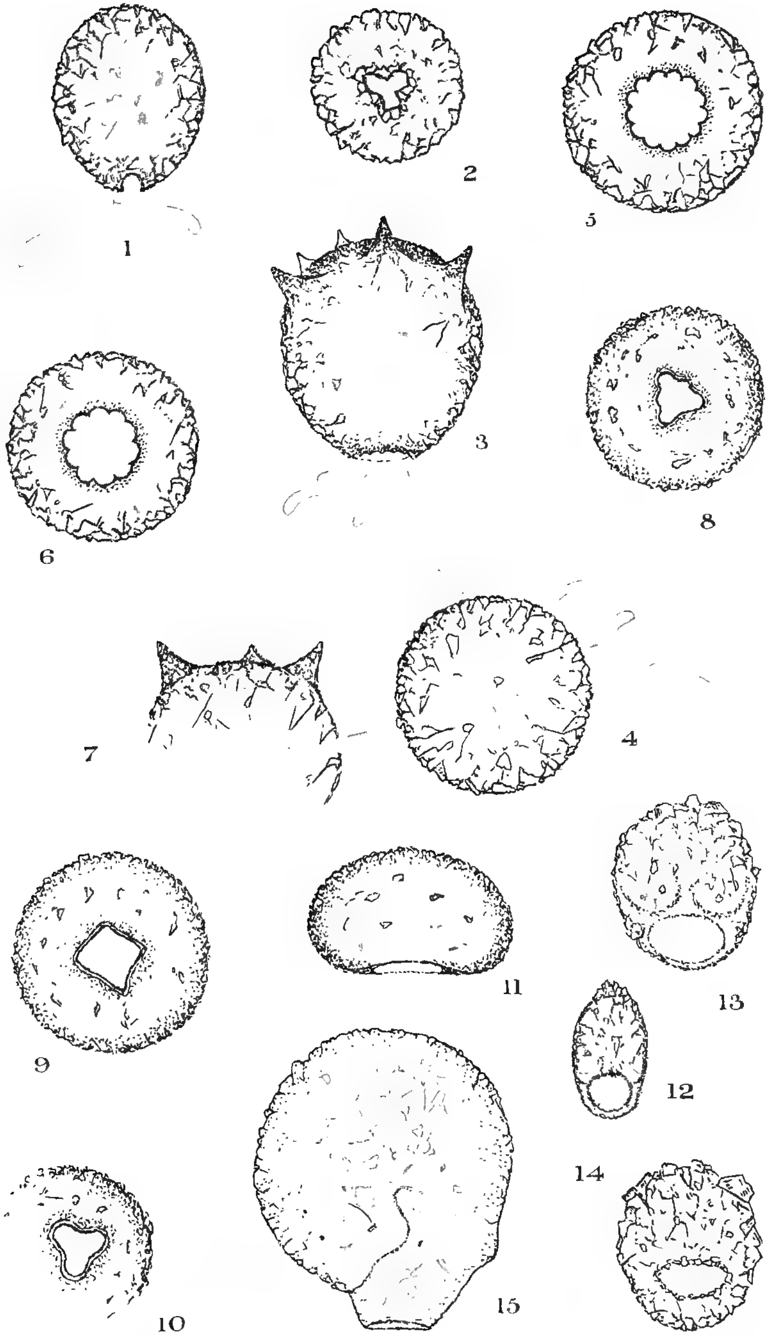
3–7. *D. corona* Wallich. (p. 49) Figs. 3, 4.—Lateral and dorsal views of a living individual, the pseudopodia in action in the dorsal view seen by focussing down. Figs. 5, 6.—Oral views of empty tests, one with a thirteen-lobed and the other with a ten-lobed mouth. Fig. 7.—Upper portion of side view of the latter showing three short spines. All from Richmond Park, Surrey. × 260.

8–11. *D. arcula* Leidy. (p. 53) Figs. 8–10.—Oral views showing variations in form of mouth. Fig. 11.—Lateral view of an empty test. Lindow, Cheshire. × 260.

12–14. *D. constricta* (Ehrenb.) Leidy. (p. 54) Various forms of this species. × 300.

15. *Lesquereusia modesta* Rhumbl. (p. 70) Outline of a typical test. Pond at Chipperfield, Herts. × 280.

PLATE XXII.



DIFFLUGIA AND LECQUEREUSIA.

Plate 23

PLATE XXIII.

Figs.

1. *Pontigulasia vas* (Leidy) Schout. (p. 59) In mosses at pond-side at Padgate near Warrington. × 300.

2. *P. bryophila* Penard. (p. 61) In *Sphagnum* from Towyn, N. Wales. × 280.

3–5. *P. compressa* (Carter) Cash. (p. 62) Figs. 3, 4.—Broad and narrow lateral views of a living individual. Fig. 5.—Typical example of an empty test. Dunham Marsh, Cheshire. × 280.

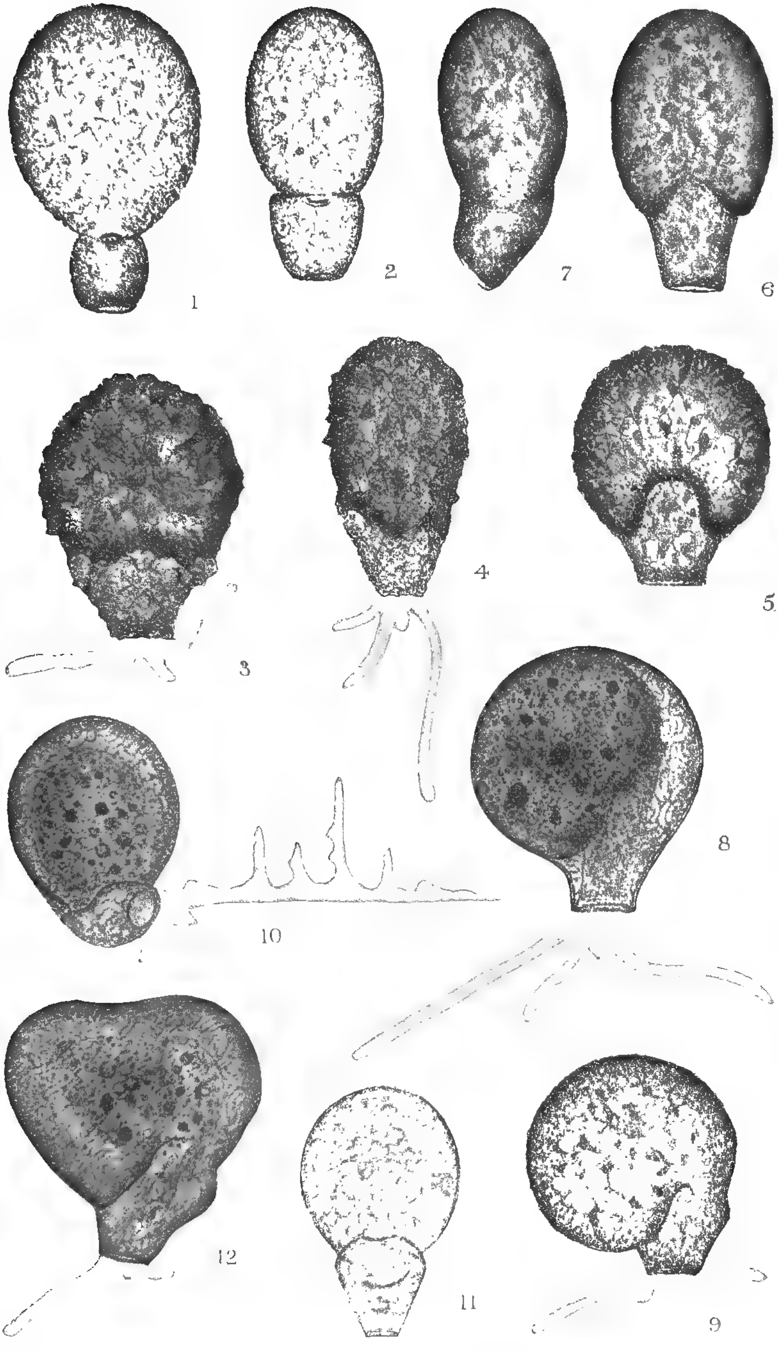
6, 7. *P. compressa* var. *flexa* Hopk. (p. 64) Broad and narrow lateral views of an empty test. Moel Siabod, N. Wales. × 260.

8. *Lesquereusia spiralis* (Ehrenb.) Bütsch. (p. 66) A living individual from Dunham Marsh. × 300.

9. *L. modesta* Rhumbl. (p. 70) A living individual from Capel Curig, N. Wales. × 200.

10, 11. *L. epistomium* Penard. (p. 71) Fig. 10.—A living individual. Fig. 11.—Side view of an empty test showing surface-markings. Dunham Marsh. × 280.

12. *L. inæqualis* Cash. (p. 72) A living example from Dunham Marsh, 1904. × 280.



PONTIGULASIA AND LECQUEREUSIA.

Plate 24

PLATE XXIV.

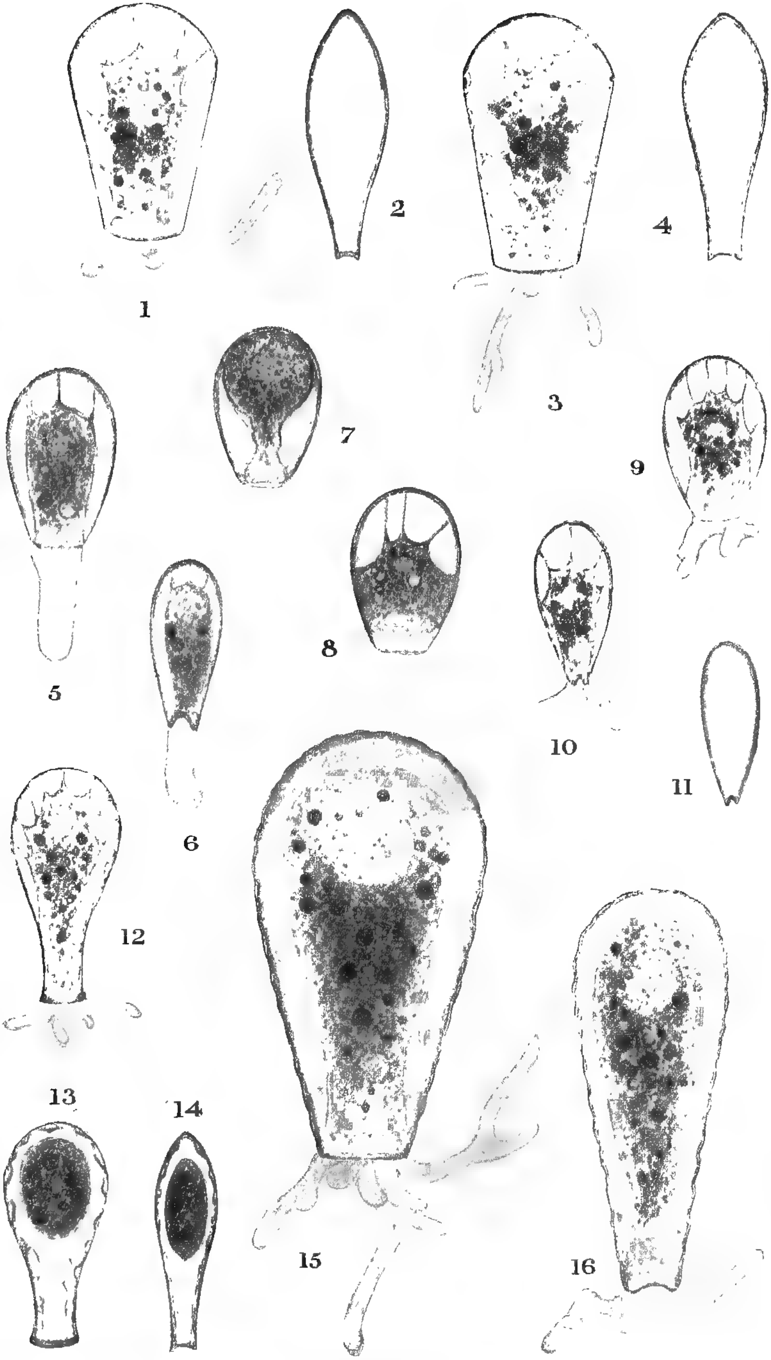
Figs.

1–4. *Hyalosphenia papilio* Leidy. (p. 81) Figs. 1, 2.—Broad and narrow views of a living individual from Knutsford Moor, Cheshire. Figs. 3, 4.—The same, from Towyn, N. Wales. Both × 260.

5–11.—*H. minuta* Cash. (p. 85) Figs. 5, 6.—Broad and narrow views of a living individual showing a single broad, tongue-like pseudopodium. Figs. 7, 8.—The same of an individual with the protoplasm retracted under irritation caused by agitation of the cover-glass. Figs. 9, 10.—The same of an individual with pseudopodia of the ordinary form. Fig. 11.—Narrow lateral view of an empty test. All from Perwick Bay, Isle of Man, August, 1891. × 600.

12–14. *H. elegans* Leidy. (p. 89) Fig. 12.—Broad view of a living individual. Figs. 13, 14.—Broad and narrow views of an encysted example. In *Sphagnum* from Aberfoyle, Scotland, July, 1906. × 300.

15, 16. *H. sinuosa* Cash. (p. 91) Broad and narrow views of an encysted individual. Knutsford Moor, August, 1901. × 280.



ENIA.

Plate 25

PLATE XXV.

Figs.

1–3. *Hyalosphenia nobilis* Cash. (p. 92) Fig. 1.—A living individual from Knutsford Moor, Cheshire. Fig. 2. —Dorsal view of the same. Fig. 3.—An empty hyaline test, showing the pitted surface. × 300.

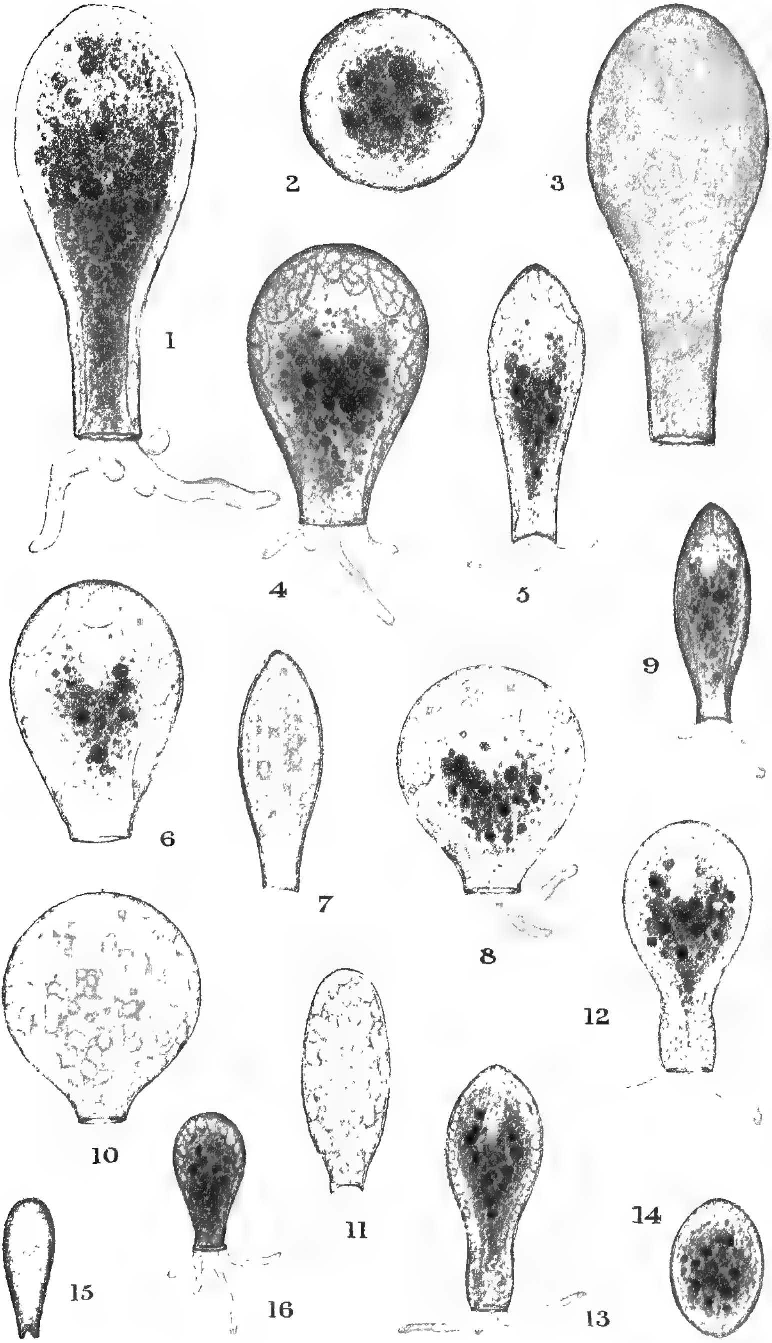
4–7. *Nebela collaris* (Ehrenb.) Leidy. (p. 93) Figs. 4, 5.—Broad and narrow views of a living individual with pseudopodia extended. Figs. 6, 7.—The same with pseudopodia retracted (the protoplasm omitted in fig. 7 to show the structure of the test). Dunham, Cheshire. × 280.

8–11. *N. tincta* (Leidy) Averintz. (p. 100) Figs. 8, 9.—Broad and narrow views of a living individual from Dunham. × 260. Figs. 10, 11.—The same of an empty test, showing external markings. × 280.

12–14. *N. lageniformis* Penard. (p. 102) Broad and narrow lateral views and dorsal view of a living individual from the margin of Llyn Idwal, N. Wales. × 280.

15, 16. *N. militaris* Penard. (p. 104) Fig. 15.—Narrow view of an empty test. Fig. 16.—Broad view of a living individual. Dunham Marsh. × 260.

PLATE XXV.



HYALOSPHENIA AND NEBELA

Plate 26

PLATE XXVI.

Nebela carinata (Archer) Leidy. (p. 105)

Figs.

1–11. A range of forms from different localities showing the extent of variation in this species. Fig. 1.—Broad view of a living individual in *Sphagnum* from Aberfoyle, Scotland, apparently the most common form in the Highlands. Figs. 2–4.—A form abundant about Llyn Idwal, N. Wales, and in other sub-alpine Welsh localities, marked by a carina of uniform thickness: 2, broad view, and 4, dorsal view of a living example; 3, narrow view of an empty test. Figs. 5–7.—Broad and narrow lateral views and dorsal view of a living example inflated in outline laterally; from Dunham, Cheshire. Fig. 8.—Broad view of a variant of the same form, encysted; from Towyn, N. Wales. Figs. 9–11.—Broad and narrow lateral views and dorsal view of a rotund form, living, from Dunham. × 280.

PLATE XXVI.

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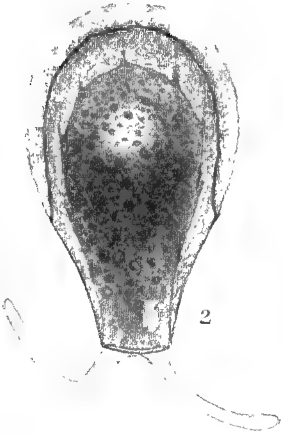
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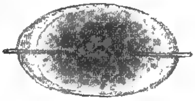
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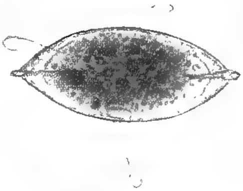
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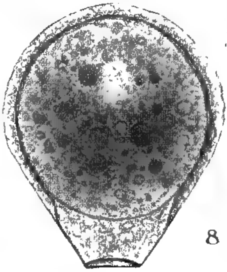
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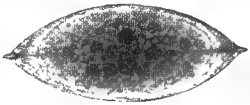
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Plate 27

PLATE XXVII.

Figs.

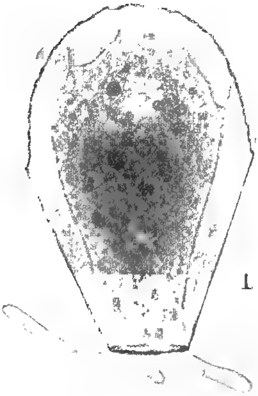
1, 2. *Nebela marginata* Penard. (p. 108) Fig. 1.—A living example. Fig. 2.—An encysted individual. Llyn Idwal, N. Wales, 1907. × 280.

3, 4. *N. tubulosa* Penard. (p. 109) Broad view of a living individual and narrow view of an empty test. Dunham, Cheshire, 1904. × 280.

5, 6. *N. barbata* Leidy. (p. 113) Broad and narrow views of an empty test. Criccieth, N. Wales. × 280.

7–9. *N. galeata* Penard. (p. 114) Broad and narrow lateral views and dorsal view of a living individual. Dunham, 1904. × 280.

PLATE XXVII.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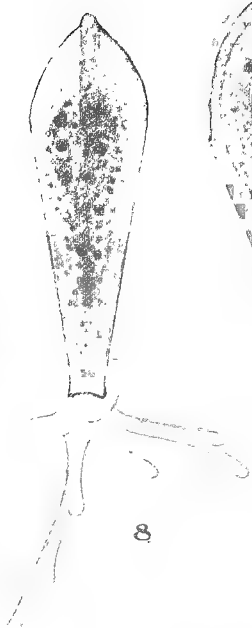
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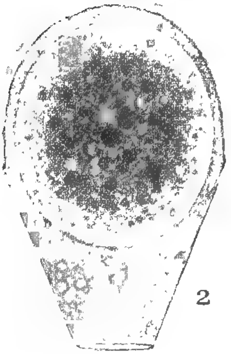
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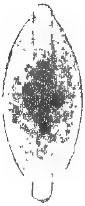
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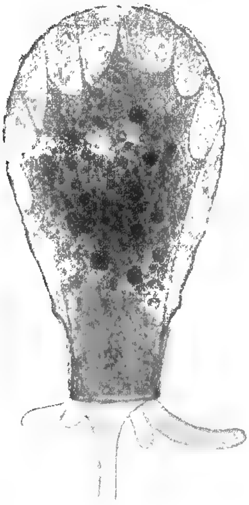
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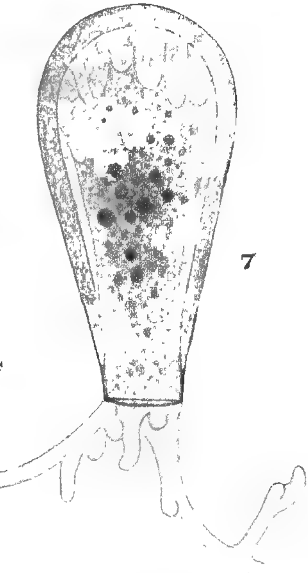
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A.

Plate 28

PLATE XXVIII.

FIGS.

1–6. *Nebela flabellulum* Leidy. (p. 117) Figs. 1, 2.—Broad lateral view and dorsal view of an active individual, in *Sphagnum* from Midlothian, Scotland, 1906. × 280. Figs. 3, 4.—The same of an encysted example from Criccieth, N. Wales. × 260. Figs. 5, 6.—Broad and narrow lateral views of a living individual from Capel Curig, N. Wales. × 280.

7, 8. *N. acolla* Cash. (p. 118) Side view and oral view of an empty test. In *Sphagnum* from Capel Curig, June, 1908. × 240.

9–11. *N. dentistoma* Penard. (p. 119) Figs. 9, 10.—Broad and narrow views of a living individual. Fig. 11.—An encysted example. Knutsford Moor, Cheshire. × 280.

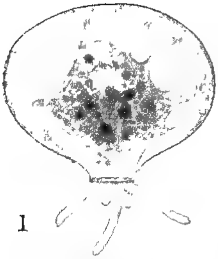
12, 13. *N. dentistoma* var. *lævis* Hopk. (p. 121) Broad view of a living example and narrow view of an empty test. Llyn Idwal, N. Wales, 1907. × 280.

14–17. *N. vitræa* Penard. (p. 121) Views of several empty tests showing variation in size and form. From various localities in North Wales. × 280.

18, 19. *Nebela tenella* Penard. (p. 122) Broad and narrow views of an encysted individual. Aberfoyle, Scotland. × 280.

20, 21. *N. parvula* Cash. (p. 123) Fig. 20.—Broad view of a living example. Fig. 21.—Narrow view of an empty test. In *Sphagnum* from the Pentlands, 1906. × 260.

PLATE XXVIII.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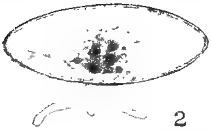
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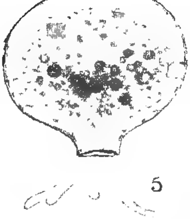
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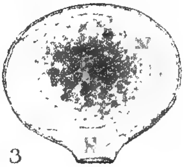
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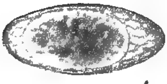
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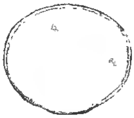
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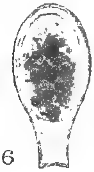
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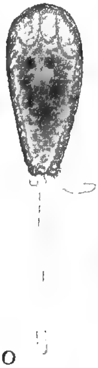
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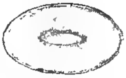
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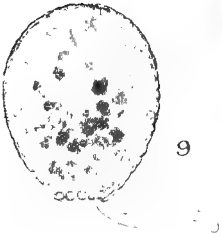
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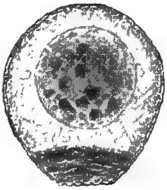
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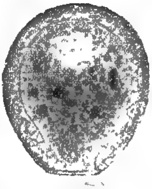
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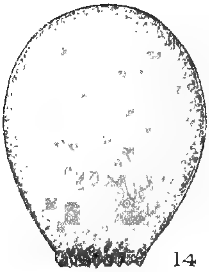
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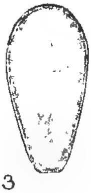
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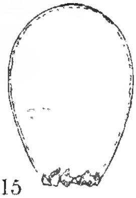
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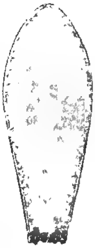
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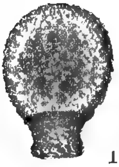
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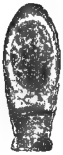
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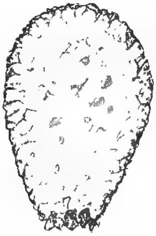
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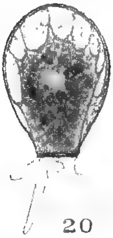
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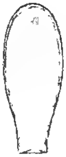
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NEBELA

Plate 29

PLATE XXIX.

Figs.

1–3. *Quadrula symmetrica* (Wallich) F. E. Sch. (p. 129) Fig. 1.—A living individual. Figs. 2, 3.—Broad and narrow views of an empty test. Dunham, Cheshire. × 280.

4–9. *Q. irregularis* Archer. (p. 132) Figs. 4, 5.—Broad and narrow views of an active individual. Fig. 6.—An encysted example. Figs. 7–9.—Broad, narrow, and oral views of an empty test. Heatley, Cheshire. × 400.

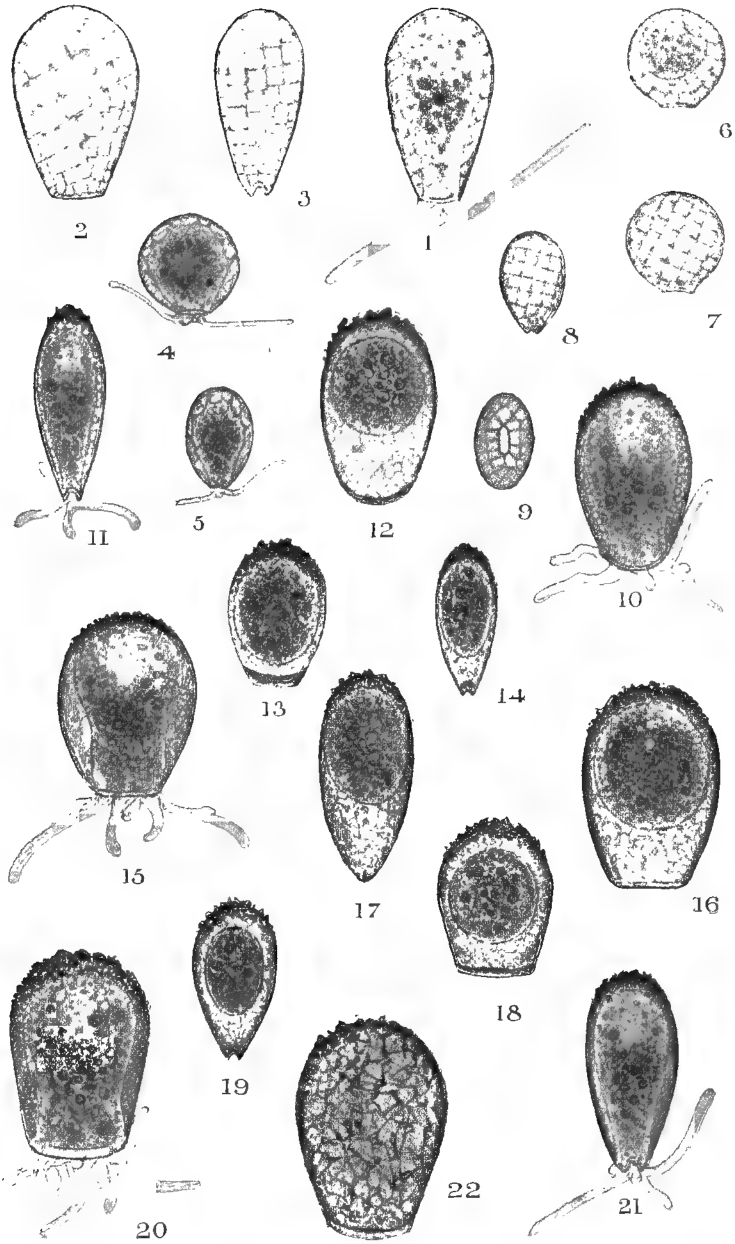
10–12. *Heleopera sylvatica* Penard. (p. 136) Broad and narrow views of a living example. Fig. 12.—An encysted example. In *Sphagnum* from Dunham. × 380.

13–19. *H. petricola* Leidy. (p. 137) Figs. 13, 14.—Broad and narrow views of an encysted individual in *Sphagnum* from the Pentland Hills. Fig. 15.—Broad view of a living example from Dunham. Figs. 16, 17.—Broad and narrow views of an encysted example in *Sphagnum* from Dunham. Figs. 18, 19.—Broad and narrow views of an encysted example in *Sphagnum* from Cader Idris, N. Wales. × 280.

20, 21. *H. petricola* var. *major* Cash. (p. 139) Broad and narrow views of an active individual. Pond-side at Padgate near Warrington. × 220.

22. *H. petricola* var. *amethystea* Penard. (p. 139) Broad view of test. Dolgoch, near Towyn, N. Wales. × 240.

PLATE XXIX.



QUADRULA AND HELEOPERA.

Plate 30

PLATE XXX.

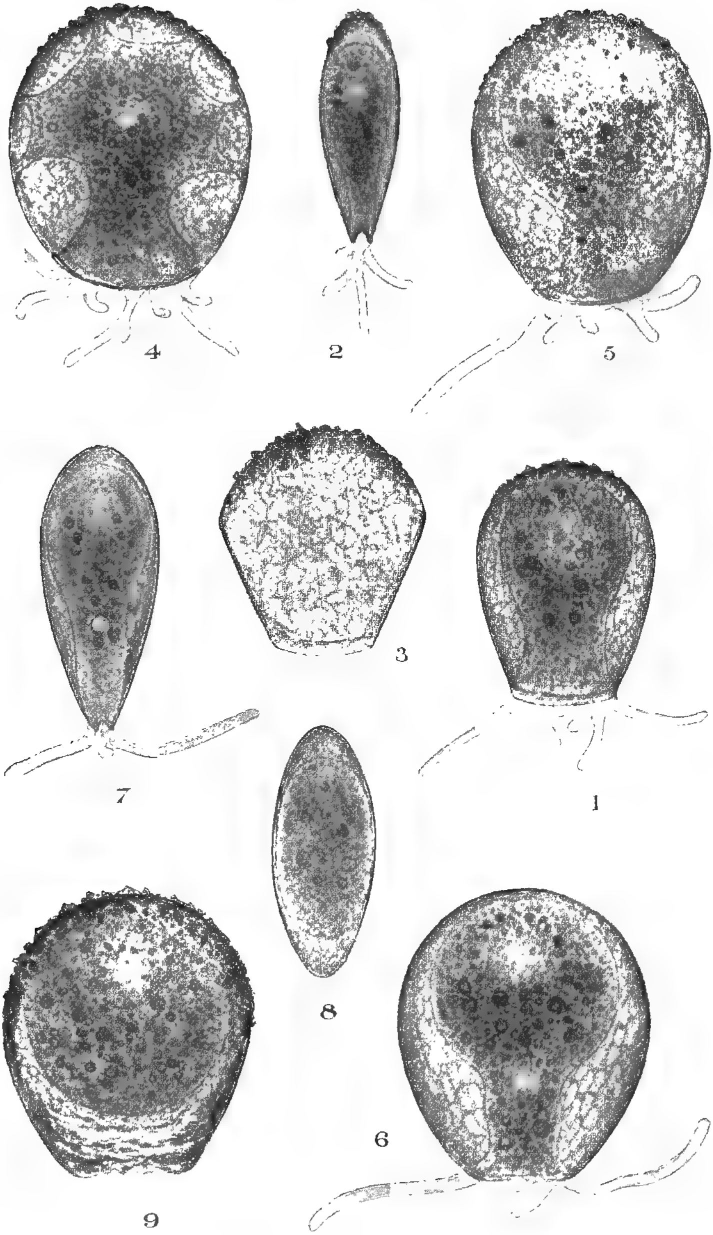
FIGS.

1, 2. *Heleopera rosea* Penard. (p. 141) Broad and narrow views of a living individual. In *Sphagnum* from Towyn, N. Wales, 1905. × 280.

3. *H. lata* Cash. (p. 142) Test, in *Sphagnum* from Towyn, 1905. × 260.

4–9. *H. sphagni* (Leidy) Hopk. (p. 143) Figs. 4, 5.—Broad views of living examples from Llyn Idwal and Towyn. Figs. 6–8.—Broad, narrow, and dorsal views of a living individual from Dunham, Cheshire. Fig. 9.—An encysted example found in a tuft of *Webera nutans* on Irlam Moss, Lancashire. × 280.

PLATE XXX.



HELEOPERA.

Plate 31

PLATE XXXI.

Figs.

1–4. *Hyalosphenia cuneata* Stein. (p. 83) Figs. 1, 2.—Broad and narrow lateral views of a living individual. After G. S. West. × 400. Figs. 3, 4.—Narrow lateral and dorsal views of test. After Penard. × 520.

5, 6. *H. inconspicua* G. S. West. (p. 84) Broad and narrow lateral views. After West. × 520.

7, 8. *H. platystoma* G. S. West. (p. 86) Broad and narrow views of a living example. After West. × 520.

9–12. *H. subflava* Cash. (p. 87) Figs. 9–11.—Broad and narrow views and form of mouth of an individual from Irlam Moss, Lancashire. Fig. 12.—An empty test from Towyn, N. Wales. × 280.

13, 14. *H. elegans* Leidy. (p. 89) Broad and narrow views of an unusually fine test from Knutsford Moor, Cheshire. × 450.

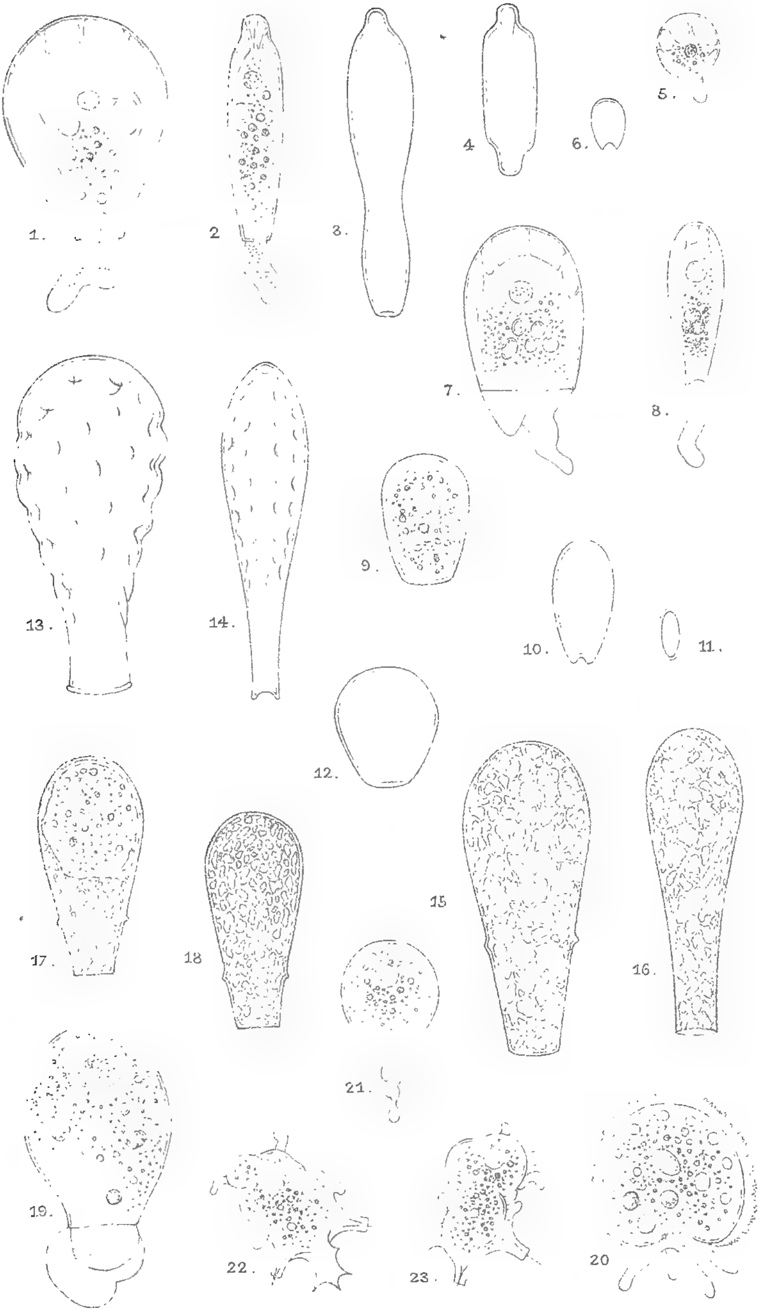
15–18. *Nebela americana* Taránek. (p. 115) Figs. 15, 16.—Broad and narrow views of an empty test from Towyn, 1904. Figs. 17, 18.—Broad views of two examples of a smaller form from Tan-y-Bwlch, 1908. × 280.

19. *Leptochlamys ampullacea* G. S. West. (p. 146) A living individual from Llyn-y-cwm-ffynon, Glyder Fawr, N. Wales. After West. × 520.

20. *Amphizonella violacea* Greeff. (p. 156) After Greeff. × about 140.

21–23. *Cochliopodium digitatum* (Greeff) Calkins. (p. 148) An individual in different states of activity. Dunham, Cheshire. × 480.

PLATE XXXI.



HYALOSPHENIA. LEPTOCHLAMYS AND COCHLIOPODIUM.

Plate 32

PLATE XXXII.

Figs.

1–11. *Cochliopodium bilimbosum* (Auerb.) Leidy. (p. 149) Figs. 1–4.—An individual in various aspects. Figs. 5–8.—Another (smaller) specimen under similar conditions. Both from ponds at Baguley, Cheshire. × 400. Fig. 9.—An example after Leidy. × 500. Figs. 10, 11.—Two aspects of a specimen from a pond at Chelford, Cheshire. × 480.

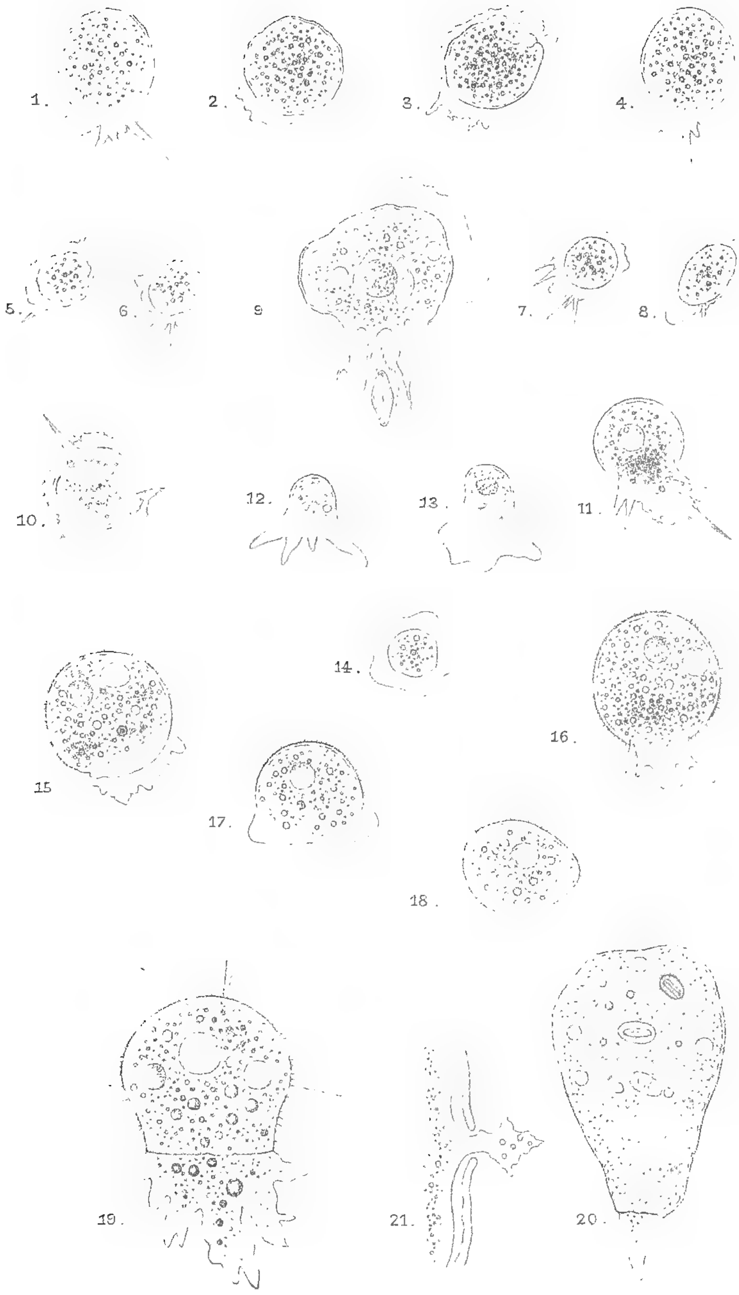
12–14. *C. minutum* G. S. West. (p. 152) An example in various phases. After West. × 520.

15–18. *C. vestitum* Archer. (p. 153) Figs. 15, 16.—Two aspects of an individual from a pond at Northen Etchells, Cheshire. Figs. 17, 18.—Two aspects of a smaller form of apparently the same species; in *Sphagnum* from Towyn, N. Wales. × 480.

19. *C. echinatum* Korotn. (p. 155) An example from Wicken Fen, Cambridgeshire. After West. × 520.

20, 21. *Zonomyxa violacea* Nüssl. (p. 158) Fig. 20.—An individual in rapid movement. After Penard. × about 150. Fig. 21.—Portion of the margin, much enlarged, showing perforation of the membrane and emission of a new pseudopodium. After Penard.

PLATE XXXII.



COCHLIOPODIUM AND ZONOMYXA.

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Storey, J. E.; 26 *Grosvenor Road, Whalley Range, Manchester.*

Sunderland Library and Literary Society; *Fawcett Street, Sunderland.*

Taverner, Henry, F.R.M.S.; 319 *Seven Sisters' Road, Finsbury Park,* N.

Terry, Charles; *Foxhill Grove, Bath.*

Tindall, William B.; 39 *St. Mary Street, and* 1315 *Traders Bank Buildings, Toronto, Canada.*

Toronto, University of; *Toronto, Canada.*

Torquay Natural History Society; *Museum, Babbacombe Road, Torquay.*

Trinity College; *Cambridge.*

Trinity College; *Dublin.*

Trondhjem, Royal Library of; *Trondhjem, Norway.*

Tupman, Lt.-Col. George Lyon, F.G.S., F.Z.S., F.R.A.S., F.R.M.S.; *Hillfoot Observatory, College Road, Harrow.*

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University College, London; *Gower Street,* W.C.

Upsala University Library; *Upsala, Sweden.*

Victoria Institute; *Worcester.*

Walker, Alfred O., F.L.S., F.Z.S.; *Ulcombe Place, Maidstone.*

Walsingham, The Right Hon. Lord, M.A., LL.D., F.R.S., F.L.S., F.Z.S., F.E.S.; *Merton Hall, Thetford.*

Warrington Municipal Museum; *Warrington.*

Warwickshire Natural History and Archæological Society; *Cliff Hill, Warwick.*

Watzlaff, Emil; 98 *Sandy Lane, Chorlton-cum-Hardy, Manchester, and* 28 *Deansgate Arcade.*

Weg, Max; 1, *Leplaystrass, Leipzig.*

Weigel, Oswald; 1 *Königstrasse, Leipzig, Germany.*

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West Kent Natural History Society; 42 *Shooter's Hill Road, Blackheath,* S.E.

West, William, F.L.S.; 26 *Woodville Terrace, Bradford.*

Whittle, F. G.; 3 *Marine Avenue, Southend-on-Sea.*

Wickes, W. D., F.L.S.; 20 *Warrior Square, Southend-on-Sea.*

Williamson, William; 4 *Meadowbank Terrace, Edinburgh.*

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Worssam, Cecil; *Hillside, St. Albans.*

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Derbyshire.

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Derby — Free Library and Museum.

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Manchester—Literary and Philosophical Society.
Manchester—Microscopical Society.
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——— Public Free Libraries.
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Salisbury — Microscopical Society.

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Worcester—Victoria Institute.

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——— West, W.
Brierley Hill—Deeley, G. P.
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——— Naturalists' Society.
Sheffield—Brady, Dr. G. S.
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Skipton—Eddy, J. R.
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York—Yorkshire Philosophical Society.

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Dumfries—Murray, J.

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——— Public Library.
——— Royal Society.
Edinburgh—Royal Scottish Museum.
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St. Andrews — McIntosh, Prof. W. C.
St. Andrews—University Library.

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Prestonkirk—Buchan-Hepburn, Sir A.

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Glasgow—Cleland, Prof. J.
——— Mitchell Library.
——— Natural History Society.
Glasgow—Royal Philosophical Society.
——— University Library.

PERTHSHIRE.

Perth—Perthshire Society of Natural Science.

RENFREWSHIRE.

Paisley—Philosophical Institution.

IRELAND.

ANTRIM.

Belfast—Belfast Library.
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CORK.

Cork—Queen's College.

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Dublin—King's Inn Library.
——— National Library of Ireland.
——— Royal College of Science.
——— Royal Dublin Society.
Dublin—Royal Irish Academy.
——— Trinity College.
Dundrum—Scharff, Dr. R. F.
Sandycove—Colgan, N.

KILDARE.

Kildare—Collins, Hon. Mrs.

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BRITISH POSSESSIONS.

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CAPE COLONY.

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Sydney—Australian Museum.
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Sydney—Royal Society of New South Wales.

SOUTH AUSTRALIA.

Adelaide—Public Library.

VICTORIA.

Melbourne—Hardy, A. D.

Melbourne—Public Library.

WESTERN AUSTRALIA.

South Perth—Giles, H. M.

CANADA.

ONTARIO.

Guelph — Ontario Agricultural College.

Toronto—Tindall, W. B.

——— University.

CEYLON.

Peradeniya—Green, E. E.

INDIA.

Calcutta—Geological Survey of India.

NEW ZEALAND.

Christchurch—Philosophical Institution of Canterbury.

Dunedin—University of Otago.

FOREIGN COUNTRIES.

AMERICA, UNITED STATES OF.

CALIFORNIA.

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New York.

Albany—New York State Library.
Buffalo—Grosvenor Public Library.
Ithaca—Cornell University.
New York—Botanical Garden.
——— Public Library.

Pennsylvania.

Philadelphia—Academy of Natural Sciences.

AUSTRIA.

Vienna—Gerold and Co.

BELGIUM.

Brussels—National Library.

FRANCE.

Lyons—Lyon Université Bibliothèque.
Paris—Bibliothèque Nationale.
Paris—Institut de France.
——— Muséum d'Histoire Naturelle.

GERMANY.

Baden—Schmidle, Prof. W.
Berlin—Dames, F. L.
——— Friedländer & Sohn.
——— Junk, W.
——— Royal Library.
——— Royal Zoological Museum.
Breslau—University Library.
Elberfeld—Roÿers, H.
Frankfort—Baer & Co.
Göttingen—University Library.
Halle a Saale—Niemeyer, Dr. M.
Hamburg—Schmidt, Dr. M.
Heidelberg—University Library.
Kiel—University Library.
Leipzig—Weg, M.
——— Weigel, O.
Munich—Royal Library.

ITALY.

Naples—Stazione Zoologica.

JAPAN.

Tokyo—OKamura, Prof. K.

NETHERLANDS.

Amsterdam—Royal Academy of Sciences.

NORWAY.

Bergen—Museums Bibliotek.
Christiana—University.
Trondhjem—Royal Library.

SWEDEN.

Stockholm—Royal Academy of Sciences.
Upsala—University Library.

SWITZERLAND.

Berne—Natural History Museum.

LIST OF THE PUBLICATIONS

OF THE

RAY SOCIETY.

For the First Year, 1844.

1. Reports on the Progress of Zoology and Botany, 1841, 1842. viii + 496 + xx pp. 8vo. 1845.

The State of Zoology in Europe, as regards the Vertebrata. By C. L. Bonaparte. Transl. by H. E. Strickland. pp. 1-44.

The Progress of Zoology in 1842. Transl. from the German by W. B. Macdonald. pp. 1-348.

The Progress of Physiological Botany in 1841. By H. F. Link. Transl. by Edwin Lankester. pp. 1-104. Index, pp. i-xx.

2. A Monograph of the British Nudibranchiate Mollusca. By Joshua Alder and Albany Hancock. Part I. x + 20 pp., 10 plates. Folio. 1845.

3. Memorials of John Ray, consisting of his Life by Dr. Derham ; . . . with his Itineraries, etc. Edited by Edwin Lankester. xii + 220 pp. 8vo. 1846.

For the Second Year, 1845.

4. On the Alternation of Generations. By J. J. S. Steenstrup. Transl. from the German version of C. H. Lorenzen by George Busk. viii + 132 pp., 3 plates. 8vo. 1845.

5. A Monograph of the British Nudibranchiate Mollusca. By Joshua Alder and Albany Hancock. Part II. iv + 34 pp., 13 plates. Folio. 1846.

6. Reports and Papers on Botany. viii + 494 pp., 7 plates. 8vo. 1846.

On the Morphology of the Coniferæ. By J. J. Zuccarini. Transl. by George Busk. pp. 1-54, 441-444, pls. i-v.

Report on Botanical Geography, 1842. By A. Grisebach. Transl. by W. B. Macdonald. pp. 55-212.

Memoir on the Nuclei, Formation, and Growth of Vegetable Cells. By Carl Nägeli. Transl. by Arthur Henfrey. pp. 213-292, 445-459, pls. vi, vii.

Report on Physiological Botany, 1842 and 1843. By H. F. Link. Transl. by J. Hudson. pp. 293-440. Index pp. 461-494.

For the third Year, 1846.

7. Outlines of the Geography of Plants. By F. J. F. Meyen. Transl. by Margaret Johnston. x + 422 pp., 1 plate. 8vo. 1846.

8. The Organization of Trilobites. By Hermann Burmeister. Edited by Thomas Bell and Edward Forbes. xii + 136 pp., 6 plates. Folio. 1846.

9. A Monograph of the British Nudibranchiate Mollusca. By Joshua Alder and Albany Hancock. Part III. iv + 30 pp., 12 plates. Folio. 1847.

For the Fourth Year, 1847.

10. Elements of Physiophilosophy. By Lorenz Oken. From the German by Alfred Tulk. xx + 666 pp. 8vo. 1847.

11. Reports on Zoology for 1843, 1844. Transl. from the German by George Busk, Alfred Tulk, and A. H. Haliday. viii + 596 pp. 8vo. 1847.

Progress of Zoology in 1843. pp. 1–232.
„ „ 1844. pp. 233–564.
Index, pp. 565-596.

12. A Monograph of the British Naked-eyed Medusæ. By Edward Forbes. viii + 104 pp., 13 plates. Folio. 1848.

For the Fifth Year, 1848.

13. Bibliographia Zoologiæ et Geologiæ. A General Catalogue of all Books, Tracts, and Memoirs on Zoology and Geology. By Louis Agassiz. Edited by H. E. Strickland. Vol. I. Periodicals, and A–B. xxvi + 506 pp. 8vo. 1848.

14. The Correspondence of John Ray. Edited by Edwin Lankester. xvi + 502 pp., 2 plates. 8vo. 1848.

15. A Monograph of the British Nudibranchiate Mollusca. By Joshua Alder and Albany Hancock. Part IV. iv + 28 pp., 12 plates. Folio. 1848.

For the Sixth Year, 1849.

16. Reports and Papers on Botany. Edited by Arthur Henfrey. viii + 514 pp., 3 plates. 8vo. 1849.

On the Structure of the Palm-stem. By H. von Mohl. pp. 1–92 495, pl. i.

On the Nuclei, Formation, and Growth of Vegetable Cells. By Carl Nägeli. Part II. pp. 93–158, 495–502, pls. ii, iii.

On the Utricular Structures in the Contents of Cells. By Carl Nägeli. pp. 159-190.

Report on Physiological Botany for 1844 and 1845. By H. T. Link. pp. 191-314.

Report on Geographical Botany for 1844. By A. GRISEBACH. pp. 315–414.

Report on Geographical and Systematic Botany for 1845. By A. GRISEBACH. pp. 415–494.

17. The Natural History of the British Entomostraca. By W. BAIRD. viii + 364 pp., 36 plates. 8vo. 1850.

For the Seventh Year, 1850.

18. Bibliographia Zoologiæ et Geologiæ. A General Catalogue of all Books, Tracts, and Memoirs on Zoology and Geology. By LOUIS AGASSIZ. Edited by H. E. STRICKLAND. Vol. II. C–F. iv + 492 pp. 8vo. 1850.

19. A Monograph of the British Nudibranchiate Mollusca. By JOSHUA ALDER and ALBANY HANCOCK. Part V. iv + 62 pp., 16 plates. Folio. 1851.

For the Eighth Year, 1851.

20. The British Species of Angiocarpous Lichens, elucidated by their Sporidia. By the Rev. W. A. LEIGHTON. vi + 102 pp., 30 plates. 8vo. 1851.

21. A Monograph of the Sub-class Cirripedia. By CHARLES DARWIN. The Lepadidæ, or Pedunculated Cirripedes. xii + 400 pp., 10 plates. 8vo. 1851.

For the Ninth Year, 1852.

22. Bibliographia Zoologiæ et Geologiæ. A General Catalogue of all Books, Tracts, and Memoirs on Zoology and Geology. By LOUIS AGASSIZ. Edited by H. E. STRICKLAND. Vol. III. G–M. vi + 658 pp. 8vo. 1852.

23. A Monograph of the British Nudibranchiate Mollusca. By JOSHUA ALDER and ALBANY HANCOCK. Part VI. iv + 62 pp., 12 plates. Folio. 1852.

For the Tenth Year, 1853.

24. Botanical and Physiological Memoirs. Edited by ARTHUR HENFREY. xvi + 568 pp., 6 plates. 8vo. 1853.

The Phenomenon of Rejuvenescence in Nature. By ALEXANDER BRAUN. pp. vii–xxvi, 1–342, pls. i–v.

The Animal Nature of Diatomeæ. By G. MENIGHINI. pp. 343–514.

The Natural History of *Protococcus pluvialis.* By FERDINAND COHN. pp. 515–564, pl. vi.

25. A Monograph of the Sub-class Cirripedia. By CHARLES DARWIN. The Balanidæ, the Verrucidæ, etc. viii + 684 pp., 30 plates. 8vo. 1854.

For the Eleventh Year, 1854.

26. Bibliographia Zoologiæ et Geologiæ. A General Catalogue of all Books, Tracts, and Memoirs on Zoology and Geology. By LOUIS AGASSIZ. Edited by H. E. STRICKLAND. Vol. IV. N–Z. vi + 604 pp. 8vo. 1854.

For the Twelfth Year, 1855.

27. A Monograph of the British Nudibranchiate Mollusca. By JOSHUA ALDER and ALBANY HANCOCK. Part VII. vi + 54 + 40 + xlvi pp., 9 plates. Folio. 1855.

For the Thirteenth Year, 1856.

28. A Monograph of the Fresh-water Polyzoa, including all the known species, both British and Foreign. By GEORGE JAMES ALLMAN. viii + 122 + 22 pp., 11 plates. Folio. 1856 [1857].

For the Fourteenth Year, 1857.

29. The Recent Foraminifera of Great Britain. By WILLIAM CRAWFORD WILLIAMSON. xx + 108 pp., 7 plates. Folio. 1858.

For the Fifteenth Year, 1858.

30. The Oceanic Hydrozoa; a Description of the Calycophoridæ and Physophoridæ. . . . By THOMAS HENRY HUXLEY. x + 144 + 24 pp., 12 plates. Folio. 1859.

For the Sixteenth Year, 1859.

31. A History of the Spiders of Great Britain and Ireland. By JOHN BLACKWALL. [Part I.] vi + 174 + 24 pp., 12 plates. Folio. 1861.

For the Seventeenth Year, 1860.

32. Introduction to the Study of the Foraminifera. By WILLIAM B. CARPENTER, assisted by WILLIAM K. PARKER and T. RUPERT JONES. xxii + 320 + 44 pp., 22 plates. Folio. 1862.

For the Eighteenth Year, 1861.

33. On the Germination, Development, and Fructification of the Higher Cryptogamia, and on the Fructification of the Coniferæ. By WILHELM HOFMEISTER. Transl. by FREDERICK CURREY. xviii + 506 pp., 65 plates. 8vo. 1862.

For the Nineteenth Year, 1862.

34. A History of the Spiders of Great Britain and Ireland. By JOHN BLACKWALL. Part II. iv + 210 (175–384) + 34 pp., 17 plates. Folio. 1864.

For the Twentieth Year, 1863.

35. The Reptiles of British India. By ALBERT C. L. G. GÜNTHER. xxviii + 452 pp., 26 plates. Folio. 1864.

For the Twenty-first Year, 1864.

36. A Monograph of the British Spongiadæ. By J. S. BOWERBANK. Vol. I. xx + 290 pp., 37 plates. 8vo. 1864.

For the Twenty-second Year, 1865.

37. The British Hemiptera. Vol. I. Hemiptera-Heteroptera. By JOHN WILLIAM DOUGLAS and JOHN SCOTT. xii + 628 + 42 pp., 21 plates. 8vo. 1865.

38. A Monograph of the British Spongiadæ. By J. S. BOWERBANK. Vol. II. xx + 388 pp. 8vo. 1866.

For the Twenty-third Year, 1866.

39. The Miscellaneous Botanical Works of ROBERT BROWN. [Edited by JOHN J. BENNETT.] Vol. I, containing I, Geographico-botanical, and II, Structural and Physiological Memoirs. viii + 612 pp. 8vo. 1866.

40. Recent Memoirs on the Cetacea. Edited by WILLIAM HENRY FLOWER. xii + 312 pp., 6 plates. Folio. 1866.

I. On the Greenland Right-Whale. By D. F. ESCHRICHT and J. REINHARDT. pp. 1–150, pls. i-vi.

II. On the Species of the Genus *Orca* inhabiting the Northern Seas. By D. F. ESCHRICHT. pp. 151–188.

III. *Pseudorca crassidens,* a Cetacean hitherto unknown in the Danish Fauna. By J. REINHARDT. pp. 189-218.

IV. Synopsis of the Cretaceous Mammalia of Scandinavia (Norway and Sweden). By W. LILLJEBORG. pp. 219–310.

41. NITZSCH'S Pterylography, translated from the German. Edited by PHILIP LUTLEY SCLATER. xii + 182 pp., 10 plates. Folio. 1867.

For the Twenty-fourth Year, 1867.

42. A Monograph on the Structure and Development of the Shoulder-girdle and Sternum in the Vertebrata. By W. KITCHEN PARKER. xii + 240 + 60 pp., 30 plates. Folio. 1868.

43. The Miscellaneous Botanical Works of ROBERT BROWN. [Edited by JOHN J. BENNETT.] Vol. II, containing III, Systematic Memoirs, and IV, Contributions to Systematic Works. viii + 780 pp. 8vo. 1868.

For the Twenty-fifth Year, 1868.

44. The Miscellaneous Botanical Works of ROBERT BROWN. [Edited by JOHN J. BENNETT.] Vol. III. Atlas of Plates. iv + 16 pp., 38 plates. Folio. 1868.

45. Vegetable Teratology, an Account of the Principal Deviations from the Usual Structure of Plants. By MAXWELL T. MASTERS. With numerous illustrations by E. M. WILLIAMS. xxxviii + 534 pages. 8vo. 1869.

For the Twenty-sixth Year, 1869.

46. A Monograph of the Gymnoblastic or Tubularian Hydroids. By GEORGE JAMES ALLMAN. Part I, the Hydroida in General. xxii + 154 + 24 pp., 12 plates. Folio. 1871.

For the Twenty-seventh Year, 1870.

47. A Monograph of the Gymnoblastic or Tubularian Hydroids. By GEORGE JAMES ALLMAN. Conclusion of Part I, and Part II, containing descriptions of the Genera and Species of the Gymnoblastea. iv + 2 (xxiii, xxiv) + 296 (155–450) + 22 pp., 11 plates (xiii–xxiii). Folio. 1872.

For the Twenty-eighth Year, 1871.

48. Monograph of the Collembola and Thysanura. By Sir JOHN LUBBOCK. x + 276 pp., 78 plates. 8vo. 1873.

For the Twenty-ninth Year, 1872.

49. A Monograph of the British Annelids. By W. C. MCINTOSH. Part I. The Nemertians. xiv + 96 + 20 pp., 10 plates. Folio. 1873.

For the Thirtieth Year, 1873.

50. A Monograph of the British Annelids. By W. C. MCINTOSH. Part I continued. The Nemertians. iv + 122 (97–214, 213 *a–d*) + 26 pp., 13 plates (xi–xxiii). Folio. 1874.

For the Thirty-first Year, 1874.

51. A Monograph of the British Spongiadæ. By J. S. BOWERBANK. Vol. III. xxviii + 368 pp., 92 plates. 8vo. 1874.

For the Thirty-second Year, 1875.

52. A Monograph of the British Aphides. By George Bowdler Buckton. Vol. I. x + 194 + 78 pp., 42 plates (A–C, i–xxxviii, iv bis). 8vo. 1876.

For the Thirty-third Year, 1876.

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